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(54) Electrostatic spraying devices

(57) An electrostatic spraying device is designed in such a way that potential surface leakage paths (Fig Ib) along which current may leak from the HT generator (26) are sufficiently long to alllow the use of a generator having a smaller than conventional maximum current output.

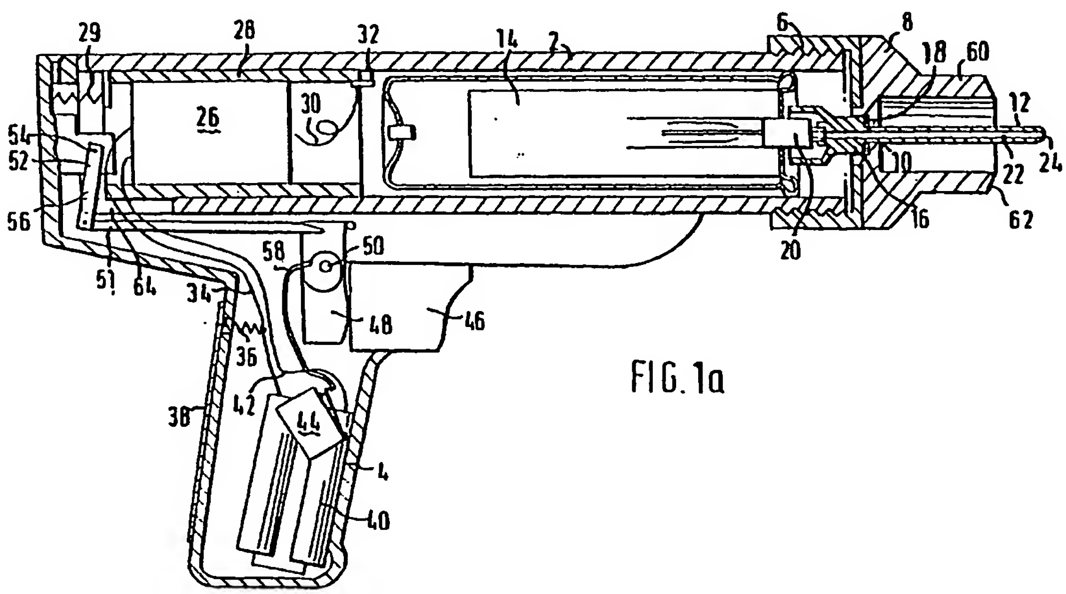

FIG.1a

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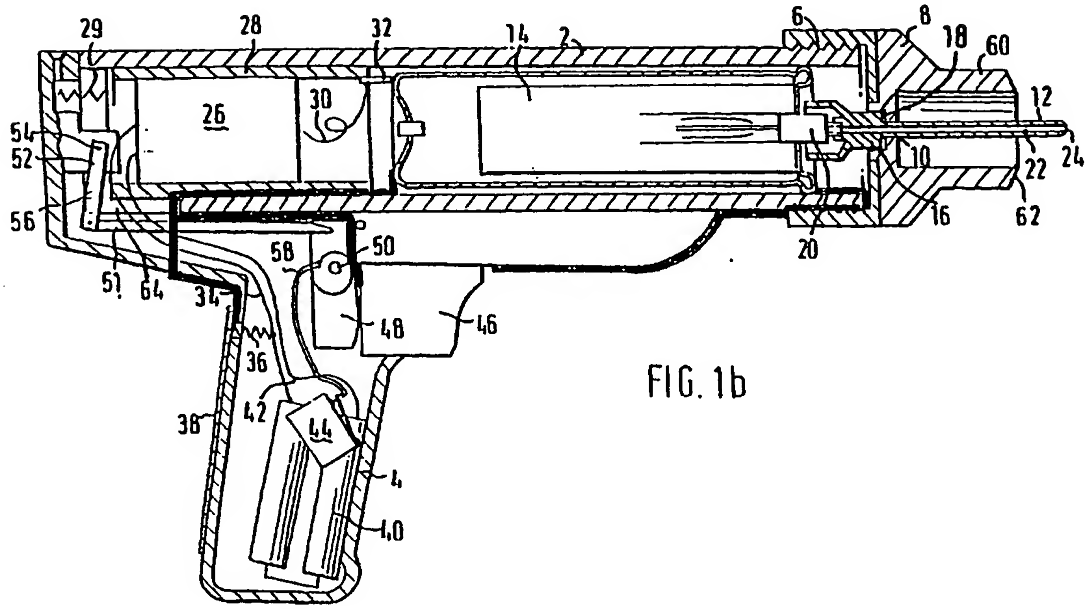
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FIG. 1b

Description

This invention relates to electrostatic spraying devices.

Energy efficiency and generator current capacity are not viewed as important in most conventional electrostatic spraying applications, since most use is in heavy industrial applications. In attempting to design small and/or hand held devices for the domestic market, for example, one of the major costs is that of the high voltage supply, usually in the form of a generator. Reducing the current output required from the generator enables it to be built less expensively. However, a problem with previously proposed devices is that if the output current of the generator is reduced significantly, the devices function less effectively or not at all.

Broadly, the inventive concept recognises that it is possible to use a generator which has a current capacity much smaller than is conventional.

In accordance with one aspect of the invention, there is provided an electrostatic spraying device comprising a nozzle, means for supplying liquid to the nozzle, high voltage supply means having a high voltage output supplying a high voltage circuit comprising one pole of the high voltage output connected, in use, so that liquid sprayed from the nozzle is electrostatically charged, in use leakage between the poles of the high voltage output of the high voltage supply being less than 0.3 microamps.

Preferably the leakage is less than 0.03 microamps.

In prior art spraying devices, the majority of the current supplied by the high voltage generator is surface leakage current and unwanted corona discharge, only a proportion being spraying current i.e. current actually used to charge the spray. For example a known hand held electrostatic crop spraying device has a spray current (to charge the spray) of about 0.5 microamps and a leakage current which, in use, can be as high as 5 microamps. Reducing the surface leakage enables a smaller generator to be used producing a potential cost saving.

In accordance with another aspect of the invention, there is provided an electrostatic spraying device comprising: a nozzle, means for supplying liquid to the nozzle, high voltage supply means having a high voltage output supplying a high voltage circuit comprising one pole of the high voltage output connected, in use, so that one or more ligaments of liquid is/are propelled from the nozzle, the ligaments breaking up into electrostatically charged droplets, the high voltage supply means having a maximum output current when the device is spraying of 1.5 microamps at 15 kV in the case of a single ligament or 0.8 microamps per 15 kV + 0.15 microamps per ligament in the case of more than one ligament.

For example, the high voltage supply means may have a maximum output current when the device is spraying of 0.6 microamps at 15 kV in the case of a single ligament or 0.3 microamps per 15 kV + 0.15 per ligament in the case of multi-ligament spraying. Where the liquid being sprayed has a suitable resistivity, i.e. of the order if 10^9 ohm cm or above, the consumption of current by non-catastrophic corona discharge is negligible and the maximum output current that the high voltage supply means is capable of producing may be 0.33 microamps per 15 kV for a single ligament sprayer or 0.03 per 15 kV + 0.15 per ligament in the case of a multi-ligament sprayer.

As referred to above, it is to be understood that a reference to a maximum output current capability of for example 0.6 microamps at 15 kV means that at 15 kV, the maximum current output capability is 0.6 microamps but for high voltage supply means designed to operate at other voltage outputs, the maximum current output capability applicable is proportionally related so that, for instance, at an operating voltage of 20 kV the maximum current output capability is 20/15 x 0.6, ie 0.8 microamps.

Where the device of the invention is designed to produce multi-ligament spraying (e.g. using an annular or linear nozzle with an extended discharge edge), it is preferably arranged to operate so as to produce a ligament to ligament pitch of at least 400 microns.

In accordance with yet another aspect of the invention there is provided electrostatic spraying device comprising: a nozzle, means for supplying liquid to the nozzle, high voltage supply means having a high voltage output supplying a high voltage circuit comprising one pole of the high voltage output connected, in use, so that liquid sprayed from the nozzle is electrostatically charged, the greatest average potential gradient, in normal use, across surfaces of the device between conductors or semiconductors connected to opposite poles of the high voltage output being less than 3 kV per cm.

Preferably the greatest average potential gradient across such surfaces is less than 2 kV per cm.

Preferably where the device is so designed that portions of such surfaces are disposed in such a way that potential current leakage paths exist across gaps between those surface portions, in normal use of the devices the air pathway potential gradient between any such surface portions is no greater that 6 kV/cm.

In comparison with normal practice at high voltages, the potential gradient is much less. This reduces the surface leakage current, so reducing the load on the generator. The generator may therefore be built less expensively.

In a yet further aspect of the invention, the liquid to be sprayed is contained in a pressurised container having a delivery valve which, in use, is opened by relative movement of the container and the nozzle towards each other, the device having a body or body part from which the nozzle extends, said valve being opened, in use, by relative movement between the container and the body or body part, the nozzle remaining fixed in relation to the body or body part.

Preferably the body or body part is formed in one

piece so that it is uninterrupted round its periphery, and formed of insulating plastics material, the nozzle projecting from one end and movement being applied to the container from the other end to operate the valve

The high voltage supply circuit may comprise a generator situated on a side of the container remote from the nozzle and having a high voltage connector for electrical connection thereto, the low voltage circuit of the generator being remote from the container, movement being applied to the container through the generator to operate the valve.

The generator preferably produces an unregulated output voltage, i.e, without employing any feedback-dependent form of voltage regulation, thereby allowing the generator to be constructed cheaply. Such a generator is particularly applicable to single ligament spraying since such spraying can tolerate a relatively wide range of operating voltages.

In a preferred embodiment of the invention the generator comprises means for converting a low voltage from a dc supply into a relatively low ac voltage, means for storing the energy content of said ac voltage, means for repeatedly discharging the energy-storing means to produce a relatively low magnitude higher frequency decaying oscillatory voltage, high gain transformer means for converting said higher frequency voltage to a large magnitude decaying oscillatory voltage (typically at least 10 kV), and means for rectifying said large magnitude voltage to provide a uni-polar high voltage output which, when applied to the device, is subject to smoothing by capacitive elements associated with the device.

Such a generator can be manufactured in a compact form and at low cost than generators of the type used conventionally which employ an array of voltage multiplier circuits to convert a low input voltage into a high voltage suitable for use in electrostatic spraying devices, and the preferred generator does not require feedback control to produce a regulated voltage output as used in conventionally used generators.

In a still further aspect of the invention there is provided an electrostatic spraying device having a nozzle and a surface near the nozzle which is sufficiently insulated as to charge to a high voltage, in use, whereby the spray from the nozzle is repelled therefrom. This reduces the amount to which the sprayed droplets spread, which may be desirable in some cases. In a preferred embodiment the surface is annular.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figures Ia and Ib are cross sectional views of an electrostatic spray gun embodying the invention;
Figures 2a and 2b are cross sectional views of another electrostatic spray gun embodying the invention;
Figure 3 is a view similar to Figures Ia and Ib but showing a modification thereof; and
Figure 4 is a block diagram of the circuitry of the high voltage generator employed in the embodiments of this invention.

DETAILED DESCRIPTION

The invention may be embodied in any shape convenient to the purpose to which it is to be put. The embodiments illustrated are both in the form of a spray gun.

The spray gun illustrated in Figure 1 has a body member 2 and a hand grip 4. The body member 2 is in the form of a tube of insulating plastics material. The tube is integral, that is to say it has no breaks round its periphery in contrast to a clam shell moulding. Suitable materials will usually be selected from a group defined by a bulk resistivity preferably greater than 10^{14} ohm cm. Given suitable thicknesses of material such bulk resistivities reduce the leakage through the material to a negligible amount. The problem is that at high voltages the leakage across the surface becomes important so that there is a requirement for high surface resistivity values in use. Thus materials which contaminate easily or absorb water easily are not suitable. For example it is preferred that the material does not absorb more than 0.7% by weight of water. Examples of suitable materials are ABS, polypropylene, polyethylene, some grades of polyvinyl chloride, acrylic, polycarbonate, acetal.

The body member is externally threaded at its end 6 to receive an end cap 8, which may also be of plastics material selected from the same group. Alternatively the end cap may be of a less insulating material, for example Tufnol Kite brand. The end cap 8 has a central aperture 10 through which, in use, a nozzle 12 projects. Means are provided, in the form of a container 14, for delivering liquid to be sprayed to the nozzle. The nozzle 12, which is permanently attached to the container 14, has a shoulder 16 which is received by a recess 18 on the inside of the end cap, thereby to locate the nozzle accurately centrally of the end cap. The container may be replaced by removing the end cap.

The container is pressurised by a liquefied propellant, e.g. fluorocarbon 134A, which is separated from the liquid to be sprayed by a metal foil sack (only part of which is shown). The supply of fluid to the nozzle 12 is switched on and off by a valve 20 with which a passage 22 in the nozzle communicates. As in the case of an aerosol can, pressing the valve 20 relatively towards the container 14 opens the valve allowing liquid to be propelled from the container by the pressurised propellant and into the passage 22 of the nozzle. An internal restriction in the container 14 limits the flow rate to a low value, e.g. 1 cc per minute and so that the liquid arrives at the outlet 24 of the nozzle at very low pressure which is not sufficient to cause any or significant atomisation. The nozzle may be conducting or insulating. It is pre-

ferred that the nozzle is insulating. The container 14 is conducting, in this example.

In the examples illustrated a single ligament issues from the tip of the nozzle. In other examples, the nozzle may be annular or in the shape of a plane blade so that a plurality of ligaments of liquid issue therefrom.

At the end of the body member 2 remote from the nozzle 12, a high voltage generator 26 is situated in a tubular carriage 28. The carriage 28 is slidable in the body member 2 and is biased away from the end cap 8 by a tension spring 29. The generator has a high voltage output pole 30 connected to a contact schematically indicated at 32 for contact with the conducting container 14. The other high voltage output pole is electrically common with a low voltage supply lead 34 and thus connected via a resistor 36 to a contact strip 38 on the exterior of the hand grip 4. The low voltage supply lead is connected to one pole of a battery 40. The other pole of the battery is connected to the generator by another low voltage supply lead 42 via a microswitch 44.

In order to increase the length of the leakage path from the high voltage output pole 30 to the lead 34 on the low voltage side of the generator, the generator is hermetically sealed in the carriage 28, e.g. by encapsulating the generator in the carriage 28 so that there is no direct surface path inside the tubular carriage 28 between the one high voltage pole 30 of the generator and the other pole 34. The insulation on the low voltage leads 34 and 42 is sufficient that there is no significant leakage through the bulk of the insulation in relation to surface leakage to a break in the insulation at the connection with the resistor 36.

In a version, as illustrated in Figure 3, the tubular carriage 28 is extended towards the nozzle end of the container 14 and is sufficiently large for the container to fit therein. This both lengthens the leakage path from the container to the resistor 36, and ensures that if there is any spillage from the container 14, it is contained by the carriage and does not contaminate the leakage path.

The valve 20 is opened, in use, by relative movement between the container 14 and the body 2, the nozzle 12 remaining fixed in relation to the body. Movement to operate the valve is applied to the container by movement of the generator. To this end, the grip 4 has a trigger 46 which when squeezed operates on one end of a lever 48 which is pivotally mounted at 50. Movement of the lever 48 is communicated by a link 51 to a further lever 52 which is pivotally mounted at one end 54. A central portion 56 of the lever 52 bears on the end of the carriage 28 remote from the container 14 so that when the trigger 46 is squeezed, resulting movement thereof is translated into movement of the carriage, and thus the container, towards the nozzle, so opening the valve 20. As this happens a linkage 58 operates the microswitch 44 so that power is supplied to the generator. The high voltage output from the generator is thus applied to the container and so to the liquid therein. The high voltage is thus conducted to the tip of the nozzle, via the liquid in the case of an insulating nozzle, where the electric field strength is sufficient to produce a charged spray.

The spray may be formed preponderantly by electrostatic forces, suitable liquids for such operation preferably having a resistivity in the range 1×10^5 to 5×10^{10} ohm cm in the case of non-aqueous liquids. In the case of more conducting liquids and aqueous systems, a jet may be produced by hydraulic pressure, even in the absence of the high voltage, which jet breaks up into coarse droplets. The addition of the high voltage improves the spray by decreasing the droplet size and, since like charges repel each other, spreading the spray out into more of a cloud.

The end cap 8 has an annular shroud 60 also formed of insulating material. In initial operation of the spray gun small amounts of charge accumulate on the outer edge 62 of the shroud. As the shroud is insulating, e.g. being made of non conducting material, e.g. Tufnol, ABS, polypropylene, polyethylene, polyvinyl chloride, acrylic, polycarbonate, acetal, and supported on the insulating body 2 leakage is sufficiently slow as to leave the shroud charged. The charge on the edge is of the same polarity as the spray which it thus repels. This reduces the tendency of the spray to lift or spread out. The shroud 60 can thus be used to control the shape of the spray and to this end may be adjustable or there may be several different interchangeable shrouds.

In use the grip is held in a hand and the trigger is squeezed as explained above. The hand contacts the conducting strip 38 to provide an earth return circuit. In relation to the high voltage circuit, any point on the relatively conducting hand is effectively short circuited to the conducting strip 38 and thus to the output pole of the high voltage generator which is connected thereto in common with the low voltage input pole.

The two shortest leakage paths between the high voltage output poles of the generator are indicated in the drawing by the heavy outlines in Figure Ib.

Recalling that in use the carriage is pressing against the rear of the container 14, one of these leakage paths is from the rear of the container 14, along the surface inside the body member 2 between it and the carriage 29, through a slot 64 through which the link 51 and lever 52 connect, and over the outer surface of the grip 4 to the conducting strip 38.

From the slot 64 in the body there is also a sub leakage path over the external surface of the tubular body member 2 (but inside the hand grip) to the finger of the operator squeezing the trigger.

Another leakage path is from the front of the container 14 across internal surfaces of the body member 2, across the surfaces through the screw thread of the end cap and over the external surfaces of the body member 14 and grip 4 to the hand of the operator and so to the conducting strip 38

In contrast to the situation if the body member 2 were a clam shell moulding, there is no direct surface path through the body member 2 since this is an integral

tube.

The generator is unregulated and has a rectified output such that, at the load presented by the spraying current and the leakage, it operates at a voltage of about 15 kV. The distance of the shortest leakage path is designed to be about 8 cm, giving an average potential gradient over the shortest leakage path of 1.88 kV per cm. In practice the average potential gradient should not be greater than 3 kV per cm, preferably not greater than 2 kV per cm. By design of the gun with regard to such parameters, the leakage current can be reduced to less than 0.3 microamps, more preferably to less than 0.03 micro amps. At a spraying rate of 1 cc per minute in the illustrated embodiments using a liquid formulation having a resistivity of the order of 10^8 ohm cm or greater, the spraying current (the current which actually charges the liquid) is less than 0.1 microamps. In multi-ligament sprayers, the usual maximum spraying current per ligament would be about 0.15 micro amps. In the case of a single ligament sprayer as illustrated, the maximum spraying current would be about 0.3 microamps. Thus, a 15 kV generator which in operation, has a maximum output current capability of 0.6 microamps at the load presented by the spraying current and the leakage, would be adequate for most applications. In other words, in order to achieve the benefits of a low cost generator, for high resistivity liquids of the order of 10^8 ohm. cm and above a 15 kV generator which when spraying produces a current which is a maximum of 0.6 microamps for a single ligament sprayer is all that is required, since the spraying current is not more than 0.3 microamps and the leakage current is not more than 0.3 microamps. Where the leakage is limited to 0.03 microamps, a generator having a maximum output current capability of about 0.33 micro amps at 15 kV is all that is required so as to provide up to 0.3 micro amps spraying current and 0.03 microamps leakage. In a single ligament sprayer, the spraying current is sometimes higher than is usual in a multi ligament sprayer. In a multi-ligament sprayer, the spraying current would not normally be above, say, 0.15 micro amps per ligament per 15 kV. For a multi ligament sprayer all that is required is a generator which, when actually working in the device, provides an output current no greater than 0.15 microamps per ligament plus an amount for leakage of 0.3 microamps, preferably 0.03 micro amps.

In the foregoing it has been assumed that current consumption through non-catastrophic corona discharge is negligible, which is generally the case especially for single ligament spraying where the operating voltage of the generator is typically of the order of 15 kV but generators with operating voltages up to 25 kV may be used without generating excessive corona discharge especially when used to spray liquids having resistivities of the order of 10^8 ohm cm. In some circumstances however, even with operating voltages of the order of 15 kV, corona discharge may consume current in amounts which are comparable or even greater than the spraying current. For example, in multi-ligament spraying with liquids of high resistivity, current consumption resulting from corona discharge will usually be negligible but may become substantial, for instance up to 1 micro amp, if dry spots develop at the spraying edge especially in the case of linear nozzles, as are often used for multi-ligament spraying. Also in the case of single ligament spraying using liquids having low resistivity, eg of the order of 5×10^6 ohm cm, or liquids containing conductive particles, corona discharge can give rise to current consumption of up to about 0.5 micro amps (usually less). Multi-ligament spraying is generally not practicable with low resistivity liquids. Thus, where a spraying device is to be used in circumstances where there may be non-negligible current consumption due to corona discharge, the generator may be selected accordingly so that it has a current output capability which is adequate to meet the load presented by the spraying current, the surface leakage path current and the current consumed by any corona discharge. Generally, where non-negligible current consumption by corona discharge is to be catered for, a generator with a maximum output current capability of about 1.5 microamps will suffice and can be fabricated as a low cost unregulated generator of the type described herein with reference to Figure 4 of the drawings.

The embodiment illustrated in Figure 2a is similar to that of Figure la except for the way in which the generator is mounted and the way the can is pressed to operate the valve.

In this embodiment the container is mounted in a tubular body part 2a equivalent to the body member 2 in the embodiment of Figure 1. The body part 2a has an end cap 8, which in this case is shown integral with the tubular part 2a. The part 2a again is formed with no breaks round its periphery, e.g. by moulding. The part 2a has a trigger 46 which is fixed thereon. Another body part 2b, in which the body part 2a telescopes, carries the generator 28 and has a hand grip 4 fixed thereon. The body parts 2a and 2b are biased apart by means not shown.

In operation the trigger 46 is squeezed towards the hand grip until the contact 32 on the generator meets the end of the container 14. Further pressure moves the container 14 in relation to the body part 2a whilst, again, the nozzle remains stationary in the part 2a. This movement operates the valve to supply liquid from the container to the nozzle producing a spray of electrostatically charged liquid as explained above.

The two shortest leakage paths are also shown in heavy outline in Figure 2 and are similar to those shown in Figure 1. One of the paths is from the rear of the container 14, along the surface between the parts 2a and 2b to the hand operating the trigger and so to the conducting strip 38. The other path is from the front of the can over the inside surfaces of the part 2a through the opening 10 (the nozzle is insulating), over the outer surfaces of the part 2a to the operator' s hand and so to the

conducting strip 39. The leakage paths are sufficiently long to achieve the required low leakage currents enabling use of the same low current generator as in the embodiment of Figure 1.

Referring to Figure 4, the high voltage generator described previously is preferably one which does not require the use of an array of voltage multiplier circuits as in conventional generators. Thus, as shown, the generator comprises an oscillator 100 receiving as its input the dc voltage provided by the battery pack 40 shown in Figure Ia for example. Typically, this input voltage is of the order of 9v. The oscillator 100 provides an oscillating output, typically of the order of 100Hz, which is converted by transformer 102 into a relatively low magnitude ac voltage (typically ca. 200v) which is applied to an energy storage and switching circuit 104, using capacitive elements to store the energy content of the output from the transformer 102. The circuit 104 is designed in such a way that the energy stored capacitively is repeatedly discharged at a frequency typically between 5 and 20 Hz, thereby producing an oscillatory output of a decaying nature (see signal depicted by reference 106), the peak output voltage of which is typically 200 v and the decay rate being such that the signal decays to virtually zero voltage within a millisecond or so. The pulsed signal 106 is applied to a high gain transformer 108 which converts it to a voltage of the order of 20-25kV (signal 110) and this signal is then applied to a half wave or full wave rectifier circuit 112 to produce the unipolar high voltage output 114 of the generator. The signal 114 is shown in its smoothed form, the smoothing being effected by stray capacitances associated with the device.

One form of generator suitable for use in the embodiments described herein is disclosed in European Patent Application No 163390.

Although the embodiments described above have used electrical contact between the liquid and a conductor, in the form of the container, to charge the liquid, other arrangements are possible. For example in another such arrangement, there is no electrical contact between the liquid and the high voltage output of the generator but a ring electrode, connected to the high voltage output of the generator surrounds the nozzle and charges the liquid by induction.

In another example, not illustrated, the nozzle is made of a porous material similar to that used for the writing element in a felt tip pen. The container may not then need to be pressurised, supply of liquid to the nozzle relying on capillary action.

Whereas the main teaching of this specification relates to the reduction of leakage across the surface of the device, those skilled in the art will recognise that the device should be of suitable materials and should have suitable radii corner radii to reduce corona discharge to a minimum so as to reduce unwanted effects of corona in loading the generator.

In order to measure leakage currents, the following technique is suggested. All the parts of the device should be assembled in their working positions, with the exception of the generator which is replaced with a non working dummy having dummy electrical connectors in places corresponding to those in the real generator. The container should either be empty or it should be ensured that there is no liquid delivered. When the nozzle is dry, especially if it is conducting, there is a tendency for corona to discharge therefrom. To prevent this the nozzle tip should be fitted with a cover sufficiently insulating and of sufficiently large diameter as to prevent corona discharge. An external generator, adjusted to the operating voltage, has its high voltage circuit connected across the dummy high voltage poles of the dummy generator, e. g. between the container and the conducting strip 38. A sensitive ammeter or electrometer is connected to measure the current from the external generator, which current represents the leakage current of the device in use.

The spraying current and any current consumed through corona discharge may be determined by using the device (with a live generator) to spray the liquid towards an imperforate catch target (e.g. a metal sheet) and interposing a grid of fine wire gauze between the device and the catch target so that the corona current is collected by the grid and the charged spray droplets are collected by the catch target. The grid and target may be connected to respective ammeters to allow the different current components to be measured. In practice, some of the droplets may tend to deposit on the grid but this can be minimised by making the aperture size defined by the intersecting wires of the grid suitably large (eg 2.5cm square).

Claims

1. A method of electrostatic spraying in which the spray is produced from a device comprising a nozzle (12), means (14) for supplying liquid to the nozzle (12), and high voltage supply means (26) having a high voltage output circuit comprising one pole (30) of the high voltage output connected, in use, so that liquid sprayed from the nozzle (12) is electrostatically charged, characterised in that the device is operated with an average potential gradient of less than 3 kV per cm across surfaces of the device between conductors or semiconductors connected to opposite poles of the high voltage output.

2. A method as claimed in Claim 1 in which the device is operated with a potential gradient of less than 2 kV per cm across surfaces of the device between conductors or semiconductors connected to opposite poles of the high voltage output.

3. An electrostatic spraying device comprising: a nozzle (12), means (14) for supplying liquid to the nozzle, high voltage supply means (26) having a high

voltage output having connected, in use, so that liquid sprayed from the nozzle (12) is electrostatically charged, the greatest average potential gradient, in normal use, across surfaces of the device between conductors or semiconductors connected to opposite poles of the high voltage output being less then 3 kV per cm.

4. A device as claimed in claim 3, wherein said greatest average potential gradient is less than 2 kV per cm.

5. A method or device as claimed in any one of Claims 1 to 4 in which the means for supplying liquid to the nozzle includes a pressurised container (14) of the liquid having a delivery valve (20) which, in use, is opened by relative movement of the container (14) and the nozzle (12) towards each other, the device having a body or body part (2) from which the nozzle (12) extends, said valve (20) being opened, in use, by relative movement between the container (14) and the body or body part (2), the nozzle (12) remaining in fixed relation to the body or body part (2).

6. A device or method as claimed in Claim 5 in which the body or body part (2) is uninterrupted round its periphery and is formed of insulating plastics material.

7. A device or method as claimed in Claim 5 or 6 in which the high voltage supply means comprises a generator (26) situated on a side of the container (14) remote from the nozzle (12) and having a high voltage connector (30, 32), the low voltage circuit of the generator (26) being remote from the container.

8. A device or method as claimed in any one of Claims 1 to 7 in which the nozzle (12) is made of insulating material.

9. A device or method as claimed in any one of Claims 1 to 8 in which the high voltage supply means (26) comprises means (100, 102) for converting a low voltage from a dc supply into a relatively low ac voltage, means (104) for storing the energy content of said ac voltage, means for repeatedly discharging the energy-storing means (104) to produce a relatively low magnitude higher frequency decaying oscillatory voltage, high gain transformer means (108) for converting said higher frequency voltage to a large magnitude decaying oscillatory voltage and means (112) for rectifying said large magnitude voltage to provide a smoothed uni-polar high voltage output.

10. A device or method as claimed in any one of Claims 1 to 4 or Claim 8 or 9 when appendant to any one of Claims 1 to 4, comprising a housing (2, 4) which is suitable for hand held use and which receives a container (14) for the liquid, the housing including a body part (2) from which the nozzle (12) extends and said body part being uninterrupted around its periphery and being formed of insulating plastics material.

11. A device or method as claimed in Claim 10 in which said container (14) is collapsible and means is provided for compressing the container in order to effect feed of liquid to the nozzle (12).

12. A device or method as claimed in Claim 10 or 11 in which the container (14) is provided with a valve (20) and in which opening of the valve (20) is effected in response to movement of the container (14) relative to the housing (2, 4).

13. A device or method as claimed in any one of Claims 10 to 12 in which the collapsible container (14) is enclosed within a casing containing fluid pressurising the container.

14. A device or method as claimed in any one of Claims 10 to 13 in which the collapsible container (14) is received in the housing (2,4) as a replaceable unit.

15. A device or method as claimed in Claim 11 in which the collapsible container (14) is enclosed within a carrier which is mounted for movement within the housing (2, 4) and in which the container is provided with a valve (20) which, in response to movement of the container (14) in a predetermined direction, is opened, said compressing means being effective to expel liquid from the container (14) upon opening of the valve (20) in response to such movement.

16. A device or method as claimed in any one of Claims 11 to 14 in which the housing (2, 4) includes a user-operable trigger (46) for controlling feed of liquid by the compressing means.

17. A device or method as claimed in any one of Claims 10 to 16 in which the high voltage means comprises a HT generator (26) mounted for movement within the housing (2, 4), movement of the HT generator (26) being effected in response to operation of a user-operable member (46) and feed of liquid from the container being controlled in response to such movement of the HT generator or of a mounting (28) for the HT generator.

18. A device or method as claimed in Claim 11 in which the container (14) is mounted for movement within the housing (2, 4) and the compressing means is controlled in response to movement of the container (14) to effect enabling and disabling of liquid feed

to the nozzle (12).

19. A device or method as claimed in any one of Claims 1 to 18 further comprising a shroud (60) of insulating material which encircles the nozzle (12) and on which a high voltage of the same polarity as that applied to the liquid is developed during spraying operation of the device.

20. A device or method as claimed in any one of Claims 1 to 4 or Claim 8 or 9 when appendant to any one of Claims 1 to 4, comprising a tubular body part (2) receiving a collapsible container (14) containing liquid to be sprayed and provided with a valve (20) to control supply of liquid from the container to the nozzle (14), said tubular body part (2) terminating in an end cap (8) which is removable to permit replacement of the container (14) and through which said nozzle (12) projects, and a shroud (60) of insulating material provided on said end cap (8) so as to encircle the nozzle and on which a high voltage of the same polarity as that applied to the liquid is developed during spraying operation of the device.

21. A device or method as claimed in any one of Claims 1 to 10 in which the high voltage means comprises an HT generator (26) mounted for movement, such movement being effected in response to operation of a user-operable member (46) forming part of the device and being effective to control supply of liquid to the nozzle (12).

22. A device or method as claimed in Claim 21 comprising an elongate tubular body part receiving in succession said HT generator (26) which is movable longitudinally within the tubular body part (2) and a collapsible container (14) containing liquid to be sprayed and provided with a valve (20) which controls supply of liquid from the container to the nozzle (12) and which is operable in response to said longitudinal movement of the HT generator (26).

23. A device or method as claimed in Claim 22 in which the collapsible container (14) is received within a suitably dimensioned casing for transmitting movement of the HT generator (26) to the valve (20) to effect opening of the latter.

24. A device or method as claimed in Claim 23 in which said casing is electrically conducting and in which said high voltage is supplied from a high voltage output of the HT generator (26) to the nozzle tip via said casing.

25. A device or method as claimed in any one of Claims 1 to 4 or any one of Claims 7 to 9 when appendant to any one of Claims 1 to 4 in which the device comprises first and second body parts (2a, 2b) which are movable relative to one another and a user operable actuator (46) which effects movement of the body parts (2a, 2b) relative to one another in such a way that the high voltage supply means (26) and the means (14) for supplying liquid are operated in response to such relative movement.

26. A device or method as claimed in any one of Claims 1 to 25 in which, in the case where the liquid comprises an aqueous system or is more conductive than non-aqueous liquids having a resistivity of 1 x 10^5 ohm cm, the liquid is discharged from the nozzle (12) as a jet by hydraulic pressure before breaking up into charged droplets.

27. A device or method as claimed in any one of Claims 1 to 26 in which the nozzle (12), liquid supply means (14) and the high voltage supply means (26) are embodied in a hand portable unit.

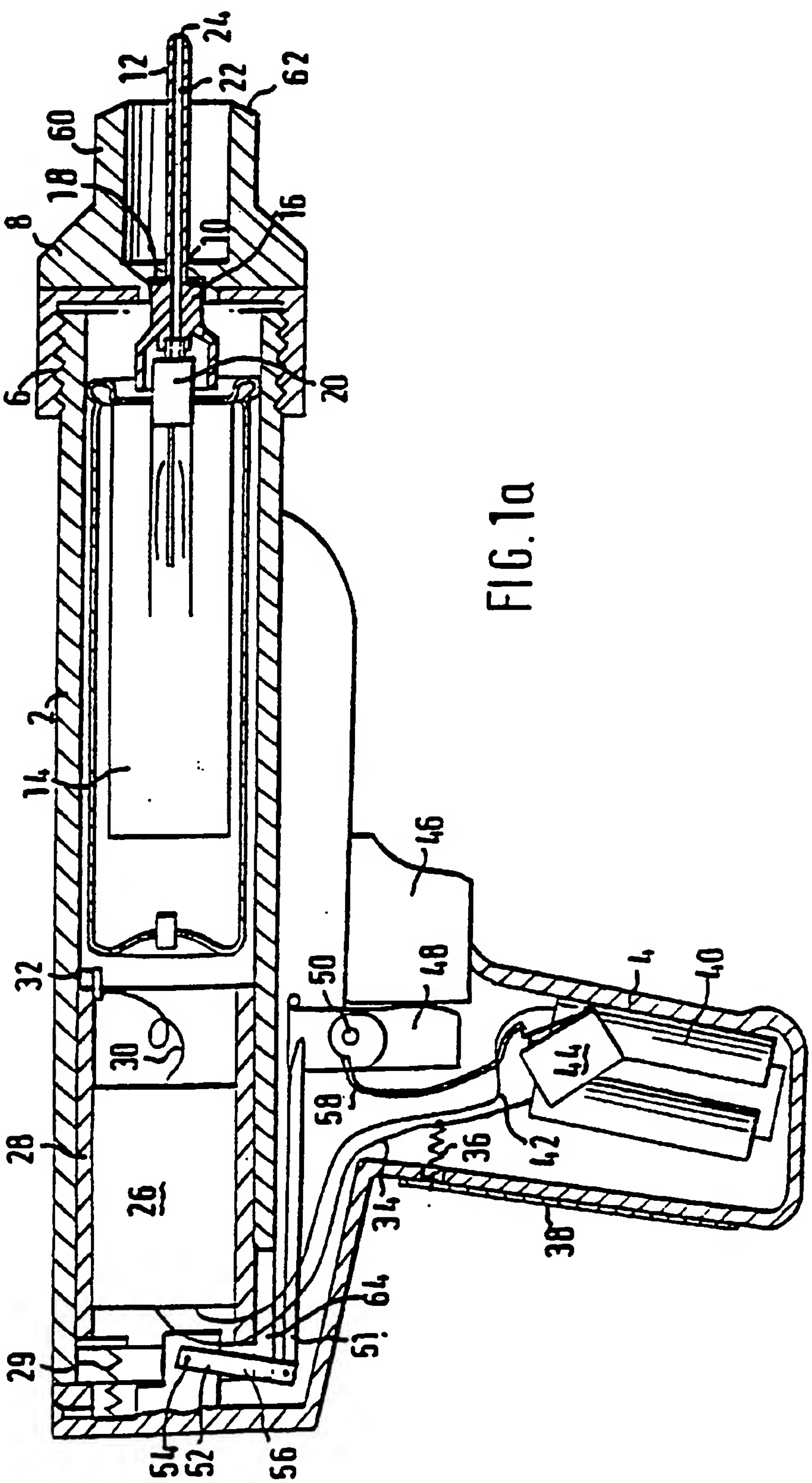
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FIG. 1a

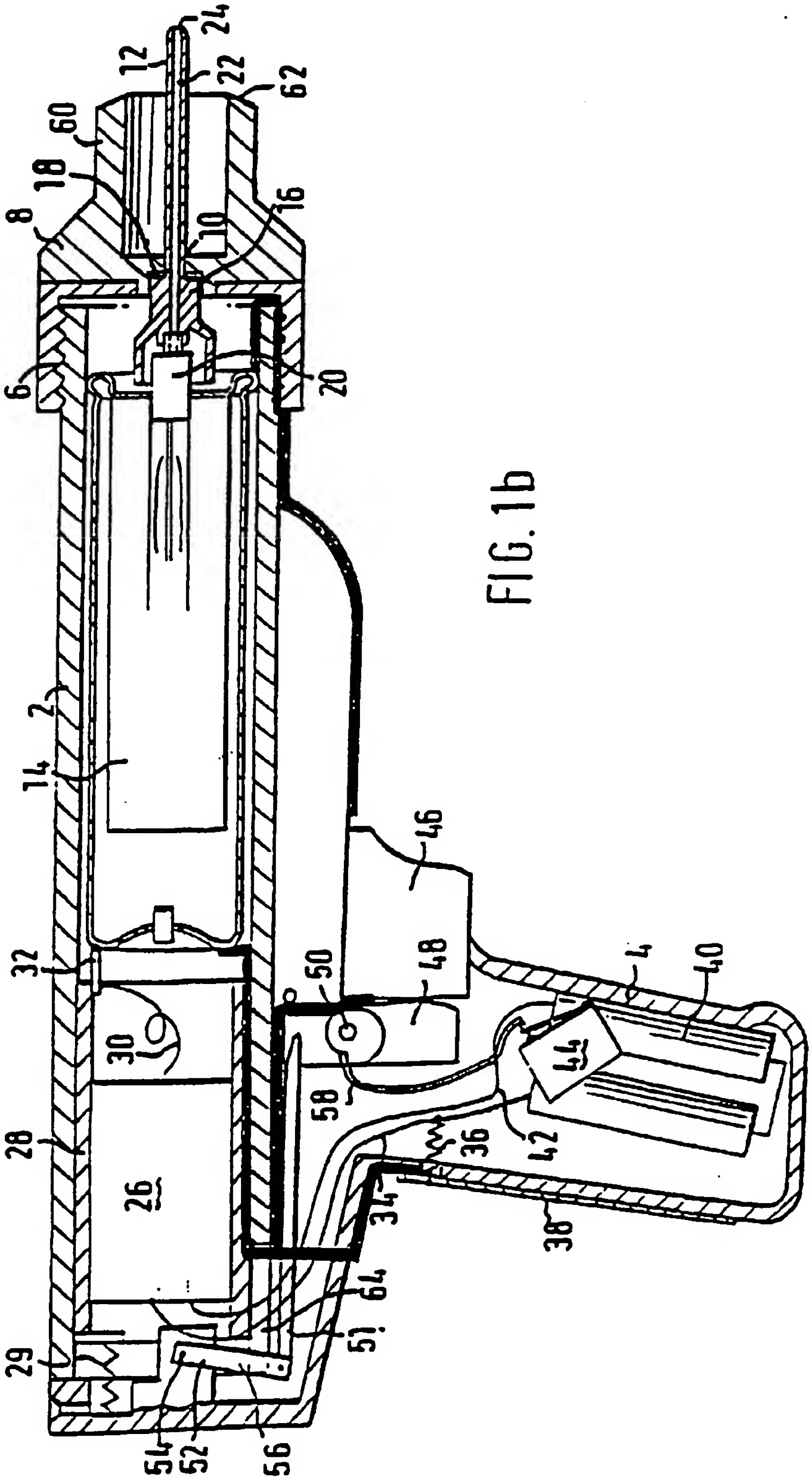
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FIG. 1b

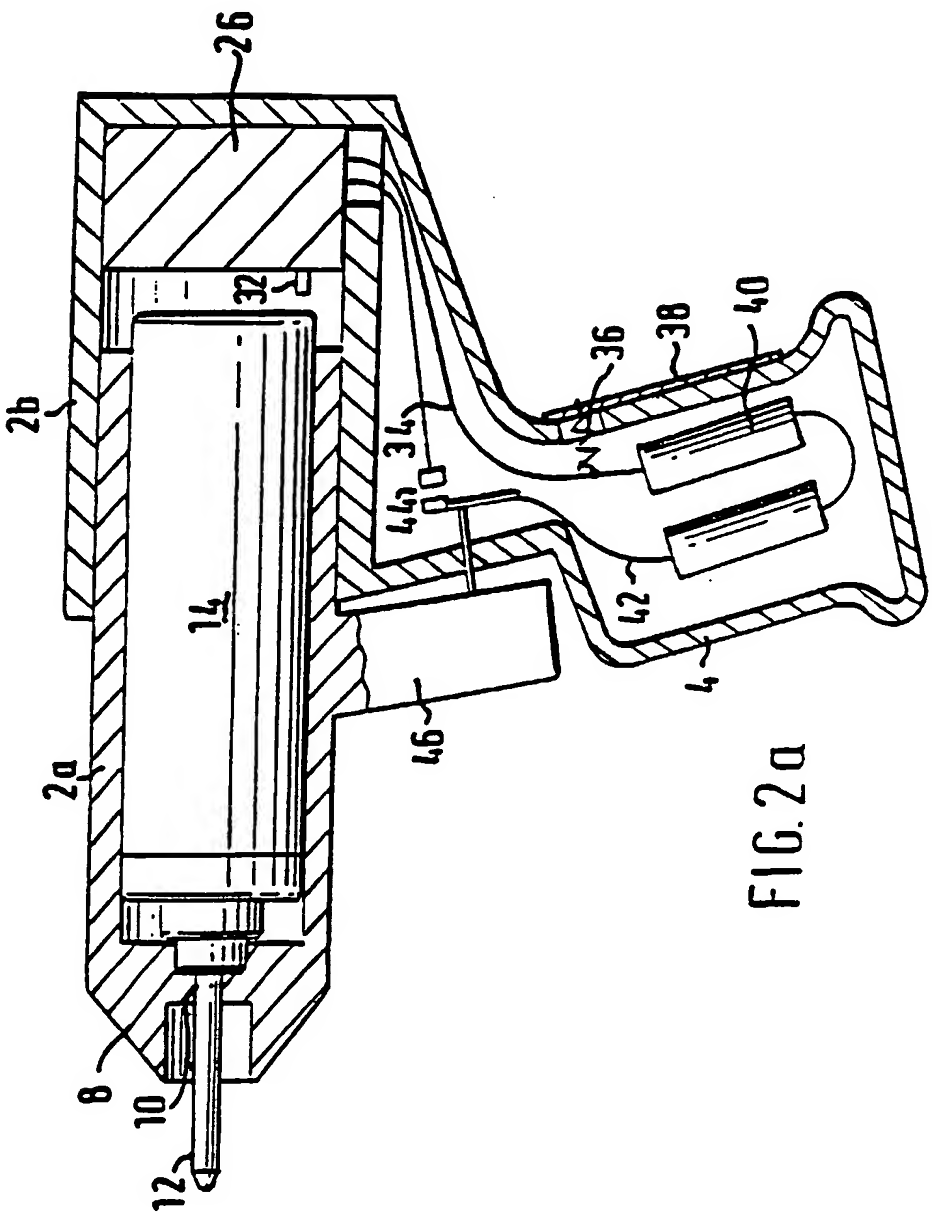

FIG. 2a

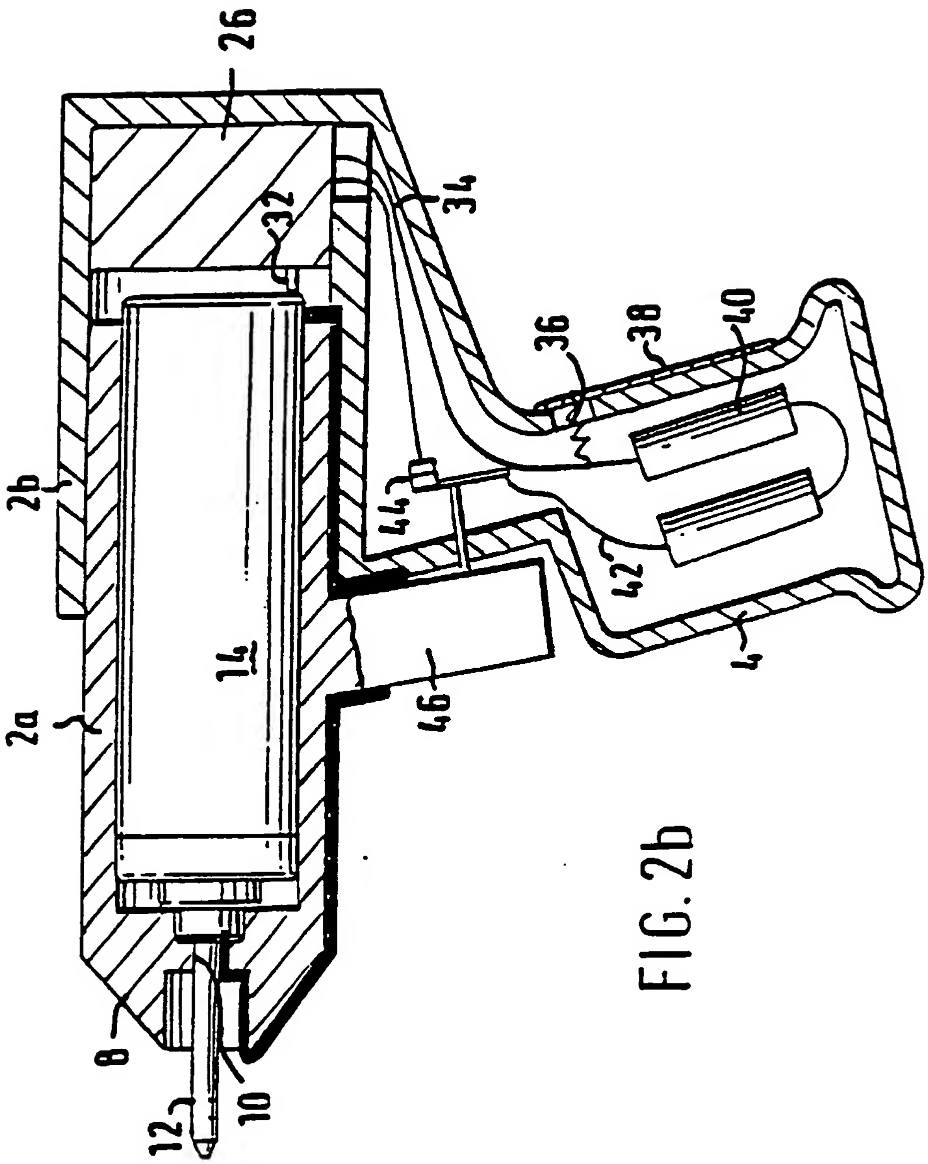

FIG. 2b

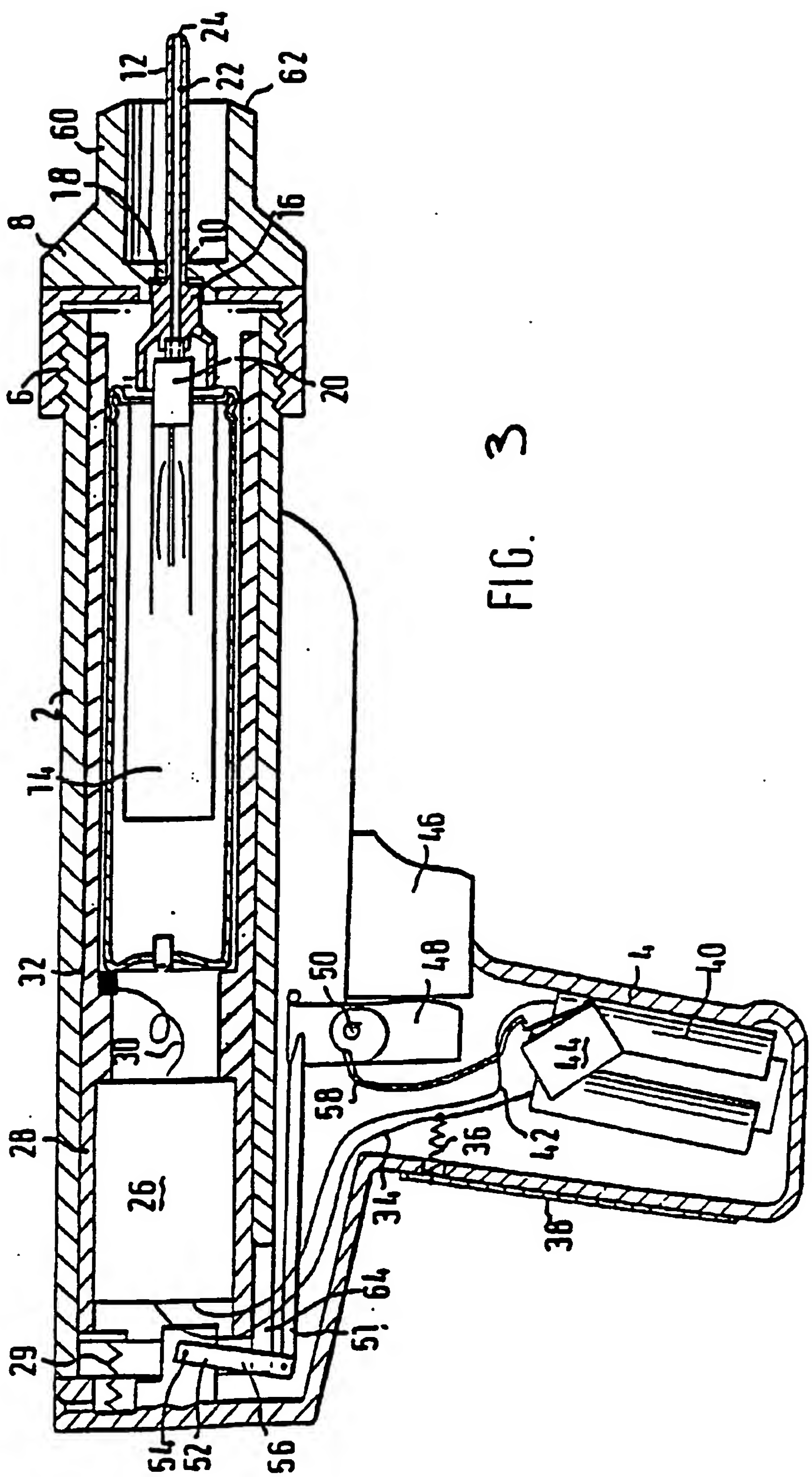
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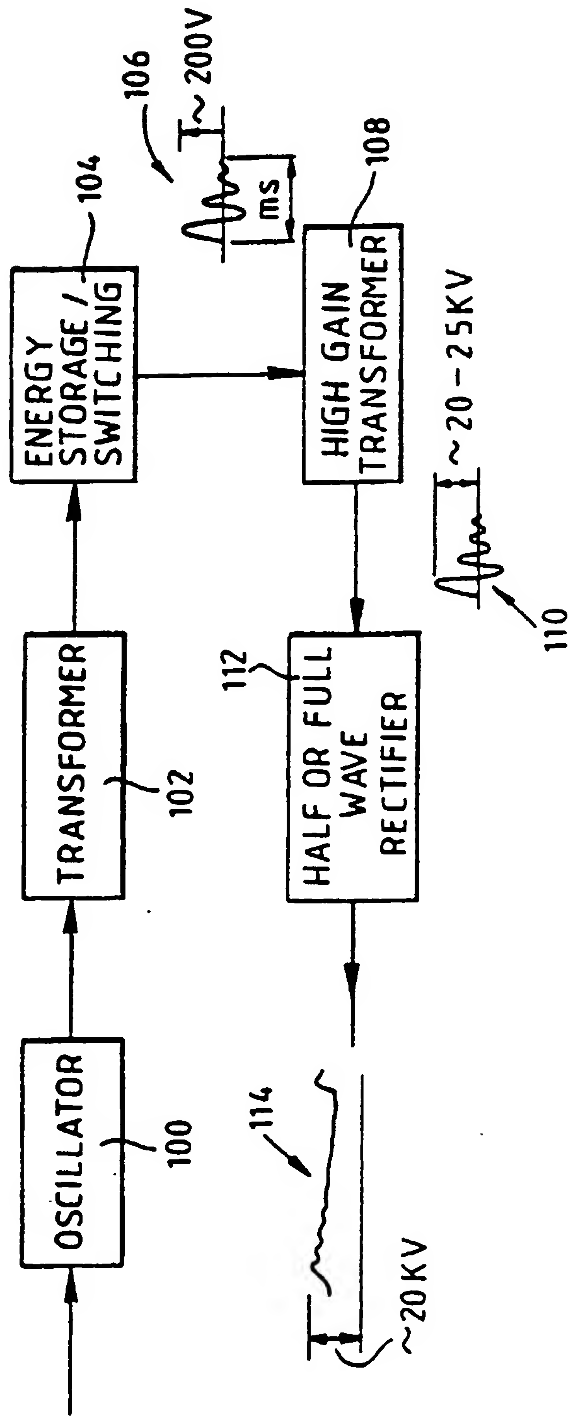
FIG. 3

Fig. 4


OSCILLATOR
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110
HALF OR FULL WAVE RECTIFIER
112
114
~20KV

(19) Europäisches Patentamt
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(54) **Electrostatic spraying devices**

(57) An electrostatic spraying device is designed in such a way that potential surface leakage paths (Fig Ib) along which current may leak from the HT generator (26) are sufficiently long to alllow the use of a generator having a smaller than conventional maximum current output.

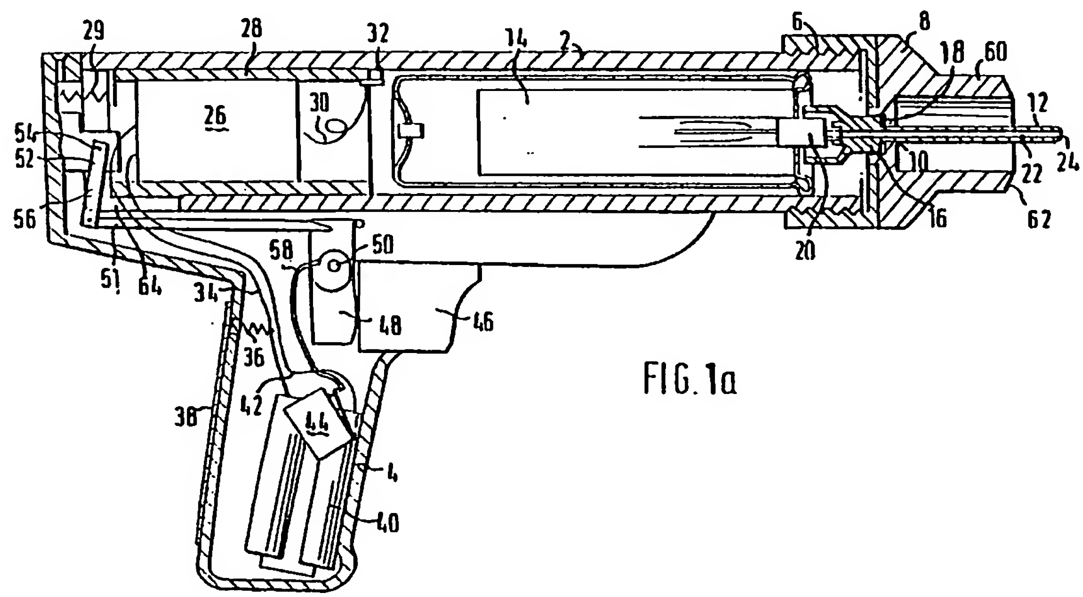

FIG.1a

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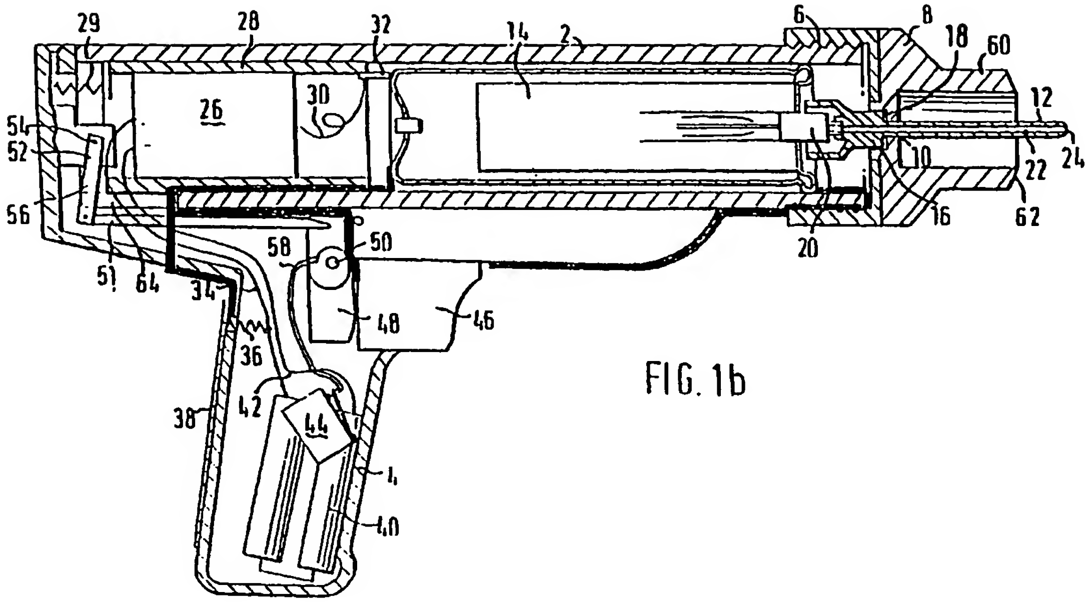
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FIG. 1b

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 10 0754

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 4 347 984 A (SICKLES) * column 4, line 28 - column 5, line 2 * * column 5, line 62 - line 66; claims 1,5; figure 2 * ---	1,2,4,5,8,26,27	B05B5/053
A	DE 10 04 558 B (METALLGESELLSCHAFT AKTIENGESELLSCHAFT) * the whole document * ---	1	
A	GB 2 197 225 A (GYÖRGY BENEDEK) * abstract; figure 1 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	24 April 1997	Guastavino, L

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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T : theory or principle underlying the invention
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D : document cited in the application
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& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

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(54) **Electrostatic spraying devices**
Elektrostatische Sprühvorrichtungen
Dispositifs de pulvérisation électrostatiques

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IT LI LU NL SE

(30) Priority: **06.02.1990 GB 9002631**

(43) Date of publication of application:
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(56) References cited:
DE-B- 1 004 558
GB-A- 2 197 225
US-A- 4 347 984

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Description

[0001] This invention relates to electrostatic spraying devices.

[0002] Energy efficiency and generator current capacity are not viewed as important in most conventional electrostatic spraying applications, since most use is in heavy industrial applications. In attempting to design small and/or hand held devices for the domestic market, for example, one of the major costs is that of the high voltage supply, usually in the form of a generator. Reducing the current output required from the generator enables it to be built less expensively. However, a problem with previously proposed devices is that if the output current of the generator is reduced significantly, the devices function less effectively or not at all.

[0003] Broadly, the inventive concept recognises that it is possible to use a generator which has a current capacity much smaller than is conventional.

[0004] US 4347984 describes an electrostatic spray coating apparatus which has a spray nozzle containing both air and liquid discharge ports and an inductive charging device which creates a charging zone and is positioned so that ambient air is mixed with air and fluid exiting from the discharge ports within the charging zone.

[0005] In accordance with one aspect of the invention there is provided a method of electrostatic spraying in which the spray is produced from a device comprising a nozzle, means for supplying liquid to the nozzle, and high voltage supply means having a high voltage output pole connected, in use, so that liquid sprayed from the nozzle is electrostatically charged, the device being operated with an average potential gradient of less than 3 kV per cm across surfaces of the device between conductors or semiconductors connected to opposite poles of the high voltage supply means, characterised in that there is electrical contact in use between the liquid and the high voltage supply means.

[0006] Preferably the device is operated with a potential gradient of less than 2 kV per cm across surfaces of the device between conductors or semiconductors connected to opposite poles of the high voltage supply means.

[0007] In accordance with another aspect of the invention there is provided an electrostatic spraying device comprising: a nozzle, means for supplying liquid to the nozzle, high voltage supply means having a high voltage output pole connected, in use, so that liquid sprayed from the nozzle is electrostatically charged, the greatest average potential gradient, in normal use, across surfaces of the device between conductors or semiconductors connected to opposite poles of the high voltage supply means being less than 3 kV per cm, characterised in that there is electrical contact in use between the liquid and the high voltage supply means.

[0008] Preferably the greatest average potential gradient is less than 2 kV per cm.

[0009] In comparison with normal practice at high voltages, the potential gradient is much less. This reduces the surface leakage current, so reducing the load on the generator. The generator may therefore be built less expensively.

[0010] The liquid to be sprayed may be contained in a pressurised container having a delivery valve which, in use, is opened by relative movement of the container and the nozzle towards each other, the device having a. body or body part from which the nozzle extends, said valve being opened, in use, by relative movement between the container and the body or body part, the nozzle remaining fixed in relation to the body or body part.

[0011] Preferably the body or body part is formed in one piece so that it is uninterrupted round its periphery, and formed of insulating plastics material, the nozzle projecting from one end and movement being applied to the container from the other end to operate the valve.

[0012] The high voltage supply means may comprise a generator situated on a side of the container remote from the nozzle and having a high voltage connector for electrical connection thereto, the low voltage circuit of the generator being remote from the container, movement being applied to the container through the generator to operate the valve.

[0013] The generator preferably produces an unregulated output voltage, i.e. without employing any feedback-dependent form of voltage regulation, thereby allowing the generator to be constructed cheaply. Such a generator is particularly applicable to single ligament spraying since such spraying can tolerate a relatively wide range of operating voltages.

[0014] In a preferred embodiment of the invention the generator comprises means for converting a low voltage from a dc supply into a relatively low ac voltage, means for storing the energy content of said ac voltage, means for repeatedly discharging the energy-storing means to produce a relatively low magnitude higher frequency decaying oscillatory voltage, high gain transformer means for converting said higher frequency voltage to a large magnitude decaying oscillatory voltage (typically at least 10 kV), and means for rectifying said large magnitude voltage to provide a uni-polar high voltage output which, when applied to the device, is subject to smoothing by capacitive elements associated with the device.

[0015] Such a generator can be manufactured in a compact form and at low cost than generators of the type used conventionally which employ an array of voltage multiplier circuits to convert a low input voltage into a high voltage suitable for use in electrostatic spraying devices, and the preferred generator does not require feedback control to produce a regulated voltage output as used in conventionally used generators.

[0016] The electrostatic spraying device may have a surface near the nozzle which is sufficiently insulated as to charge to a high voltage, in use, whereby the spray from the nozzle is repelled therefrom. This reduces the amount to which the sprayed droplets spread, which

may be desirable in some cases. In a preferred embodiment the surface is annular.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figures 1a and 1b are cross sectional views of an electrostatic spray gun embodying the invention;
Figures 2a and 2b are cross sectional views of another electrostatic spray gun embodying the invention;
Figure 3 is a view similar to Figures 1a and 1b but showing a modification thereof; and
Figure 4 is a block diagram of the circuitry of the high voltage generator employed in the embodiments of this invention.

DETAILED DESCRIPTION

[0018] The invention may be embodied in any shape convenient to the purpose to which it is to be put. The embodiments illustrated are both in the form of a spray gun.

[0019] The spray gun illustrated in Figure 1 has a body member 2 and a hand grip 4. The body member 2 is in the form of a tube of insulating plastics material. The tube is integral, that is to say it has no breaks round its periphery in contrast to a clam shell moulding. Suitable materials will usually be selected from a group defined by a bulk resistivity preferably greater than 10^{14} ohm cm. Given suitable thicknesses of material such bulk resistivities reduce the leakage through the material to a negligible amount. The problem is that at high voltages the leakage across the surface becomes important so that there is a requirement for high surface resistivity values in use. Thus materials which contaminate easily or absorb water easily are not suitable. For example it is preferred that the material does not absorb more than 0.7% by weight of water. Examples of suitable materials are ABS, polypropylene, polyethylene, some grades of polyvinyl chloride, acrylic, polycarbonate, acetal.

[0020] The body member is externally threaded at its end 6 to receive an end cap 8, which may also be of plastics material selected from the same group. Alternatively the end cap may be of a less insulating material, for example Tufnol Kite brand. The end cap 8 has a central aperture 10 through which, in use, a nozzle 12 projects. Means are provided, in the form of a container 14, for delivering liquid to be sprayed to the nozzle. The nozzle 12, which is permanently attached to the container 14, has a shoulder 16 which is received by a recess 18 on the inside of the end cap, thereby to locate the nozzle accurately centrally of the end cap. The container may be replaced by removing the end cap.

[0021] The container is pressurised by a liquefied propellant, e.g. fluorocarbon 134A, which is separated from the liquid to be sprayed by a metal foil sack (only part of which is shown). The supply of fluid to the nozzle 12 is switched on and off by a valve 20 with which a passage 22 in the nozzle communicates. As in the case of an aerosol can, pressing the valve 20 relatively towards the container 14 opens the valve allowing liquid to be propelled from the container by the pressurised propellant and into the passage 22 of the nozzle. An internal restriction in the container 14 limits the flow rate to a low value, e.g. 1 cc per minute and so that the liquid arrives at the outlet 24 of the nozzle at very low pressure which is not sufficient to cause any or significant atomisation. The nozzle may be conducting or insulating. It is preferred that the nozzle is insulating. The container 14 is conducting, in this example.

[0022] In the examples illustrated a single ligament issues from the tip of the nozzle. In other examples, the nozzle may be annular or in the shape of a plane blade so that a plurality of ligaments of liquid issue therefrom.

[0023] At the end of the body member 2 remote from the nozzle 12, a high voltage generator 26 is situated in a tubular carriage 28. The carriage 28 is slidable in the body member 2 and is biased away from the end cap 8 by a tension spring 29. The generator has a high voltage output pole 30 connected to a contact schematically indicated at 32 for contact with the conducting container 14. The other high voltage output pole is electrically common with a low voltage supply lead 34 and thus connected via a resistor 36 to a contact strip 38 on the exterior of the hand grip 4. The low voltage supply lead is connected to one pole of a battery 40. The other pole of the battery is connected to the generator by another low voltage supply lead 42 via a microswitch 44.

[0024] In order to increase the length of the leakage path from the high voltage output pole 30 to the lead 34 on the low voltage side of the generator, the generator is hermetically sealed in the carriage 28, e.g. by encapsulating the generator in the carriage 28 so that there is no direct surface path inside the tubular carriage 28 between the one high voltage pole 30 of the generator and the other pole 34. The insulation on the low voltage leads 34 and 42 is sufficient that there is no significant leakage through the bulk of the insulation in relation to surface leakage to a break in the insulation at the connection with the resistor 36.

[0025] In a version, as illustrated in Figure 3, the tubular carriage 28 is extended towards the nozzle end of the container 14 and is sufficiently large for the container to fit therein. This both lengthens the leakage path from the container to the resistor 36, and ensures that if there is any spillage from the container 14, it is contained by the carriage and does not contaminate the leakage path.

[0026] The valve 20 is opened, in use, by relative movement between the container 14 and the body 2, the nozzle 12 remaining fixed in relation to the body. Movement to operate the valve is applied to the container by movement of the generator. To this end, the grip

4 has a trigger 46 which when squeezed operates on one end of a lever 48 which is pivotally mounted at 50. Movement of the lever 48 is communicated by a link 51 to a further lever 52 which is pivotally mounted at one end 54. A central portion 56 of the lever 52 bears on the end of the carriage 28 remote from the container 14 so that when the trigger 46 is squeezed, resulting movement thereof is translated into movement of the carriage, and thus the container, towards the nozzle, so opening the valve 20. As this happens a linkage 58 operates the microswitch 44 so that power is supplied to the generator. The high voltage output from the generator is thus applied to the container and so to the liquid therein. The high voltage is thus conducted to the tip of the nozzle, via the liquid in the case of an insulating nozzle, where the electric field strength is sufficient to produce a charged spray.

[0027] The spray may be formed preponderantly by electrostatic forces, suitable liquids for such operation preferably having a resistivity in the range 1 x 10^5 to 5 x 10^{10} ohm cm in the case of non-aqueous liquids. In the case of more conducting liquids and aqueous systems, a jet may be produced by hydraulic pressure, even in the absence of the high voltage, which jet breaks up into coarse droplets. The addition of the high voltage improves the spray by decreasing the droplet size and, since like charges repel each other, spreading the spray out into more of a cloud.

[0028] The end cap 8 has an annular shroud 60 also formed of insulating material. In initial operation of the spray gun small amounts of charge accumulate on the outer edge 62 of the shroud. As the shroud is insulating, e.g. being made of non conducting material, e.g. Tufnol, ABS, polypropylene, polyethylene, polyvinyl chloride, acrylic, polycarbonate, acetal, and supported on the insulating body 2 leakage is sufficiently slow as to leave the shroud charged. The charge on the edge is of the same polarity as the spray which it thus repels. This reduces the tendency of the spray to lift or spread out. The shroud 60 can thus be used to control the shape of the spray and to this end may be adjustable or there may be several different interchangeable shrouds.

[0029] In use the grip is held in a hand and the trigger is squeezed as explained above. The hand contacts the conducting strip 38 to provide an earth return circuit. In relation to the high voltage circuit, any point on the relatively conducting hand is effectively short circuited to the conducting strip 38 and thus to the output pole of the high voltage generator which is connected thereto in common with the low voltage input pole.

[0030] The two shortest leakage paths between the high voltage output poles of the generator are indicated in the drawing by the heavy outlines in Figure Ib.

[0031] Recalling that in use the carriage is pressing against the rear of the container 14, one of these leakage paths is from the rear of the container 14, along the surface inside the body member 2 between it and the carriage 29, through a slot 64 through which the link 51 and lever 52 connect, and over the outer surface of the grip 4 to the conducting strip 38.

[0032] From the slot 64 in the body there is also a sub leakage path over the external surface of the tubular body member 2 (but inside the hand grip) to the finger of the operator squeezing the trigger.

[0033] Another leakage path is from the front of the container 14 across internal surfaces of the body member 2, across the surfaces through the screw thread of the end cap and over the external surfaces of the body member 14 and grip 4 to the hand of the operator and so to the conducting strip 38

[0034] In contrast to the situation if the body member 2 were a clam shell moulding, there is no direct surface path through the body member 2 since this is an integral tube.

[0035] The generator is unregulated and has a rectified output such that, at the load presented by the spraying current and the leakage, it operates at a voltage of about 15 kV. The distance of the shortest leakage path is designed to be about 8 cm, giving an average potential gradient over the shortest leakage path of 1.88 kV per cm. In practice the average potential gradient should not be greater than 3 kV per cm, preferably not greater than 2 kV per cm. By design of the gun with regard to such parameters, the leakage current can be reduced to less than 0.3 microamps, more preferably to less than 0.03 micro amps. At a spraying rate of 1 cc per minute in the illustrated embodiments using a liquid formulation having a resistivity of the order of 10^0 ohm cm or greater, the spraying current (the current which actually charges the liquid) is less than 0.1 microamps. In multi-ligament sprayers, the usual maximum spraying current per ligament would be about 0.15 micro amps. In the case of a single ligament sprayer as illustrated, the maximum spraying current would be about 0.3 microamps. Thus, a 15 kV generator which in operation, has a maximum output current capability of 0.6 microamps at the load presented by the spraying current and the leakage, would be adequate for most applications. In other words, in order to achieve the benefits of a low cost generator, for high resistivity liquids of the order of 10^8 ohm. cm and above a 15 kV generator which when spraying produces a current which is a maximum of 0.6 microamps for a single ligament sprayer is all that is required, since the spraying current is not more than 0.3 microamps and the leakage current is not more than 0.3 microamps. Where the leakage is limited to 0.03 microamps, a generator having a maximum output current capability of about 0.33 micro amps at 15 kV is all that is required so as to provide up to 0.3 micro amps spraying current and 0.03 microamps leakage. In a single ligament sprayer, the spraying current is sometimes higher than is usual in a multi ligament sprayer. In a multi-ligament sprayer, the spraying current would not normally be above, say, 0.15 micro amps per ligament per 15 kV. For a multi ligament sprayer all that is required is a generator which, when actually working in the device, pro-

vides an output current no greater than 0.15 microamps per ligament plus an amount for leakage of 0.3 microamps, preferably 0.03 micro amps.

[0036] In the foregoing it has been assumed that current consumption through non-catastrophic corona discharge is negligible, which is generally the case especially for single ligament spraying where the operating voltage of the generator Is typically of the order of 15 kV but generators with operating voltages up to 25 kV may be used without generating excessive corona discharge especially when used to spray liquids having resistivities of the order of 10^8 ohm cm. In some circumstances however, even with operating voltages of the order of 15 kV, corona discharge may consume current in amounts which are comparable or even greater than the spraying current. For example, in multi-ligament spraying with liquids of high resistivity, current consumption resulting from corona discharge will usually be negligible but may become substantial, for instance up to 1 micro amp, if dry spots develop at the spraying edge especially in the case of linear nozzles, as are often used for multi-ligament spraying. Also in the case of single ligament spraying using liquids having low resistivity, eg of the order of 5×10^6 ohm cm, or liquids containing conductive particles, corona discharge can give rise to current consumption of up to about 0.5 micro amps (usually less). Multi-ligament spraying is generally not practicable with low resistivity liquids. Thus, where a spraying device is to be used in circumstances where there may be non-negligible current consumption due to corona discharge, the generator may be selected accordingly so that it has a current output capability which is adequate to meet the load presented by the spraying current, the surface leakage path current and the current consumed by any corona discharge. Generally, where non-negligible current consumption by corona discharge is to be catered for, a generator with a maximum output current capability of about 1.5 microamps will suffice and can be fabricated as a low cost unregulated generator of the type described herein with reference to Figure 4 of the drawings.

[0037] The embodiment illustrated in Figure 2a is similar to that of Figure 1a except for the way in which the generator is mounted and the way the can is pressed to operate the valve.

[0038] In this embodiment the container is mounted in a tubular body part 2a equivalent to the body member 2 in the embodiment of Figure 1. The body part 2a has an end cap 8, which in this case is shown integral with the tubular part 2a. The part 2a again is formed with no breaks round its periphery, e.g. by moulding. The part 2a has a trigger 46 which is fixed thereon. Another body part 2b, in which the body part 2a telescopes, carries the generator 28 and has a hand grip 4 fixed thereon. The body parts 2a and 2b are biased apart by means not shown.

[0039] In operation the trigger 46 is squeezed towards the hand grip until the contact 32 on the generator meets the end of the container 14. Further pressure moves the container 14 In relation to the body part 2a whilst, again, the nozzle remains stationary in the part 2a. This movement operates the valve to supply liquid from the container to the nozzle producing a spray of electrostatically charged liquid as explained above.

[0040] The two shortest leakage paths are also shown in heavy outline in Figure 2 and are similar to those shown in Figure 1. One of the paths is from the rear of the container 14, along the surface between the parts 2a and 2b to the hand operating the trigger and so to the conducting strip 38. The other path is from the front of the can over the inside surfaces of the part 2a through the opening 10 (the nozzle is insulating), over the outer surfaces of the part 2a to the operator' s hand and so to the conducting strip 39. The leakage paths are sufficiently long to achieve the required low leakage currents enabling use of the same low current generator as in the embodiment of Figure 1.

[0041] Referring to Figure 4, the high voltage generator described previously is preferably one which does not require the use of an array of voltage multiplier circuits as in conventional generators. Thus, as shown, the generator comprises an oscillator 100 receiving as its input the dc voltage provided by the battery pack 40 shown in Figure 1a for example. Typically, this input voltage is of the order of 9v. The oscillator 100 provides an oscillating output, typically of the order of 100Hz, which is converted by transformer 102 into a relatively low magnitude ac voltage (typically ca. 200v) which is applied to an energy storage and switching circuit 104, using capacitive elements to store the energy content of the output from the transformer 102. The circuit 104 is designed in such a way that the energy stored capacitively is repeatedly discharged at a frequency typically between 5 and 20 Hz, thereby producing an oscillatory output of a decaying nature (see signal depicted by reference 106), the peak output voltage of which is typically 200 v and the decay rate being such that the signal decays to virtually zero voltage within a millisecond or so. The pulsed signal 106 is applied to a high gain transformer 108 which converts it to a voltage of the order of 20-25kV (signal 110) and this signal is then applied to a half wave or full wave rectifier circuit 112 to produce the unipolar high voltage output 114 of the generator. The signal 114 is shown in its smoothed form, the smoothing being effected by stray capacitances associated with the device.

[0042] One form of generator suitable for use In the embodiments described herein Is disclosed In European Patent Application No 163390.

[0043] The embodiments described above have used electrical contact between the liquid and a conductor, in the form of the container, to charge the liquid. Other arrangements in which there is no electrical contact between the liquid and the high voltage output of the generator are outside the scope of the invention.

[0044] In another example, not Illustrated, the nozzle

is made of a porous material similar to that used for the writing element in a felt tip pen. The container may not then need to be pressurised, supply of liquid to the nozzle relying on capillary action.

[0045] Whereas the main teaching of this specification relates to the reduction of leakage across the surface of the device, those skilled in the art will recognise that the device should be of suitable materials and should have suitable radii corner radii to reduce corona discharge to a minimum so as to reduce unwanted effects of corona in loading the generator.

[0046] In order to measure leakage currents, the following technique is suggested. All the parts of the device should be assembled in their working positions, with the exception of the generator which is replaced with a non working dummy having dummy electrical connectors in places corresponding to those in the real generator. The container should either be empty or it should be ensured that there is no liquid delivered. When the nozzle is dry, especially if it is conducting, there is a tendency for corona to discharge therefrom. To prevent this the nozzle tip should be fitted with a cover sufficiently insulating and of sufficiently large diameter as to prevent corona discharge. An external generator, adjusted to the operating voltage, has its high voltage circuit connected across the dummy high voltage poles of the dummy generator, e.g. between the container and the conducting strip 38. A sensitive ammeter or electrometer is connected to measure the current from the external generator, which current represents the leakage current of the device in use.

[0047] The spraying current and any current consumed through corona discharge may be determined by using the device (with a live generator) to spray the liquid towards an imperforate catch target (e.g. a metal sheet) and interposing a grid of fine wire gauze between the device and the catch target so that the corona current is collected by the grid and the charged spray droplets are collected by the catch target. The grid and target may be connected to respective ammeters to allow the different current components to be measured. In practice, some of the droplets may tend to deposit on the grid but this can be minimised by making the aperture size defined by the intersecting wires of the grid suitably large (eg 2.5cm square).

Claims

1. A method of electrostatic spraying in which the spray is produced from a device comprising a nozzle (12), means (14) for supplying liquid to the nozzle (12), and high voltage supply means (26) having a high voltage output pole (30) connected, in use, so that liquid sprayed from the nozzle (12) is electrostatically charged, the device being operated with an average potential gradient of less than 3 kV per cm across surfaces of the device between conductors or semiconductors connected to opposite poles of the high voltage supply means (26), **characterised in that** there is electrical contact in use between the liquid and the high voltage supply means (26).

2. A method as claimed in Claim 1 in which the device is operated with a potential gradient of less than 2 kV per cm across surfaces of the device between conductors or semiconductors connected to opposite poles of the high voltage supply means (26).

3. An electrostatic spraying device comprising: a nozzle (12), means (14) for supplying liquid to the nozzle high voltage supply means (26) having a high voltage output pole (30) connected, in use, so that liquid sprayed from the nozzle (12) is electrostatically charged, the greatest average potential gradient, in normal use, across surfaces of the device between conductors or semiconductors connected to opposite poles of the high voltage supply means (26) being less than 3 kV per cm, **characterised in that** there is electrical contact in use between the liquid and the high voltage supply means (26).

4. A device as claimed in Claim 3, wherein said greatest average potential gradient is less than 2 kV per cm.

5. A method or device as claimed in any one of Claims 1 to 4 in which the means for supplying liquid to the nozzle includes a pressurised container (14) of the liquid having a delivery valve (20) which, in use, is opened by relative movement of the container (14) and the nozzle (12) towards each other, the device having a body or body part (2) from which the nozzle (12) extends, said valve (20) being opened, in use, by relative movement between the container (14) and the body or body part (2), the nozzle (12) remaining in fixed relation to the body or body part (2).

6. A device or method as claimed in Claim 5 in which the body or body part (2) is uninterrupted round its periphery and is formed of insulating plastics material.

7. A device or method as claimed in Claim 5 or 6 in which the high voltage supply means comprises a generator (26) situated on a side of the container (14) remote from the nozzle (12) and having a high voltage connector (30, 32), the low voltage circuit of the generator (26) being remote from the container.

8. A device or method as claimed in any one of Claims 1 to 7 in which the nozzle (12) is made of insulating material.

9. A device or method as claimed in any one of Claims 1 to 8 in which the high voltage supply means (26) comprises means (100, 102) for converting a low voltage from a dc supply into a relatively low ac voltage, means (104) for storing the energy content of said ac voltage, means for repeatedly discharging the energy-storing means (104) to produce a relatively low magnitude higher frequency decaying oscillatory voltage, high gain transformer means (108) for converting said higher frequency voltage to a large magnitude decaying oscillatory voltage and means (112) for rectifying said large magnitude voltage to provide a smoothed uni-polar high voltage output.

10. A device or method as claimed in any one of Claims 1 to 4 or Claim 8 or 9 when appendant to any one of Claims 1 to 4, comprising a housing (2, 4) which is suitable for hand held use and which receives a container (14) for the liquid, the housing including a body part (2) from which the nozzle (12) extends and said body part being uninterrupted around its periphery and being formed of insulating plastics material.

11. A device or method as claimed in Claim 10 in which said container (14) is collapsible and means is provided for compressing the container in order to effect feed of liquid to the nozzle (12).

12. A device or method as claimed in Claim 10 or 11 in which the container (14) is provided with a valve (20) and in which opening of the valve (20) is effected in response to movement of the container (14) relative to the housing (2, 4).

13. A device or method as claimed in any one of Claims 10 to 12 in which the collapsible container (14) is enclosed within a casing containing fluid pressurising the container.

14. A device or method as claimed in any one of Claims 10 to 13 in which the collapsible container (14) is received in the housing (2,4) as a replaceable unit.

15. A device or method as claimed in Claim 11 in which the collapsible container (14) is enclosed within a carrier which is mounted for movement within the housing (2, 4) and in which the container is provided with a valve (20) which, in response to movement of the container (14) in a predetermined direction, is opened, said compressing means being effective to expel liquid from the container (14) upon opening of the valve (20) in response to such movement.

16. A device or method as claimed in any one of Claims 11 to 14 in which the housing (2, 4) includes a user-operable trigger (46) for controlling feed of liquid by the compressing means.

17. A device or method as claimed in any one of Claims 10 to 16 in which the high voltage means comprises a HT generator (26) mounted for movement within the housing (2, 4), movement of the HT generator (26) being effected in response to operation of a user-operable member (46) and feed of liquid from the container being controlled in response to such movement of the HT generator or of a mounting (28) for the HT generator.

18. A device or method as claimed in Claim 11 in which the container (14) is mounted for movement within the housing (2, 4) and the compressing means is controlled in response to movement of the container (14) to effect enabling and disabling of liquid feed to the nozzle (12).

19. A device or method as claimed in any one of Claims 1 to 18 further comprising a shroud (60) of insulating material which encircles the nozzle (12) and on which a high voltage of the same polarity as that applied to the liquid is developed during spraying operation of the device.

20. A device or method as claimed in any one of Claims 1 to 4 or Claim 8 or 9 when appendant to any one of Claims 1 to 4, comprising a tubular body part (2) receiving a collapsible container (14) containing liquid to be sprayed and provided with a valve (20) to control supply of liquid from the container to the nozzle (14), said tubular body part (2) terminating in an end cap (8) which is removable to permit replacement of the container (14) and through which said nozzle (12) projects, and a shroud (60) of insulating material provided on said end cap (8) so as to encircle the nozzle and on which a high voltage of the same polarity as that applied to the liquid is developed during spraying operation of the device.

21. A device or method as claimed in any one of Claims 1 to 10 in which the high voltage means comprises an HT generator (26) mounted for movement, such movement being effected in response to operation of a user-operable member (46) forming part of the device and being effective to control supply of liquid to the nozzle (12).

22. A device or method as claimed in Claim 21 comprising an elongate tubular body part receiving in succession said HT generator (26) which is movable longitudinally within the tubular body part (2) and a collapsible container (14) containing liquid to be sprayed and provided with a valve (20) which controls supply of liquid from the container to the nozzle (12) and which is operable in response to said longitudinal movement of the HT generator (26).

23. A device or method as claimed in Claim 22 in which the collapsible container (14) is received within a suitably dimensioned casing for transmitting movement of the HT generator (26) to the valve (20) to effect opening of the latter.

24. A device or method as claimed in Claim 23 in which said casing is electrically conducting and in which said high voltage is supplied from a high voltage output of the HT generator (26) to the nozzle tip via said casing.

25. A device or method as claimed in any one of Claims 1 to 4 or any one of Claims 7 to 9 when appendant to any one of Claims 1 to 4 in which the device comprises first and second bodyparts (2a, 2b) which are movable relative to one another and a user operable actuator (46) which effects movement of the body parts (2a, 2b) relative to one another in such a way that the high voltage supply means (26) and the means (14) for supplying liquid are operated in response to such a relative movement.

26. A device or method as claimed in any one of Claims 1 to 25 in which, in the case where the liquid comprises an aqueous liquid or is more conductive than non-aqueous liquids having a resistivity of 1 x 10^5 ohm cm, the liquid is discharged from the nozzle (12) as a jet by hydraulic pressure before breaking up into charged droplets.

27. A device or method as claimed in any one of Claims 1 to 26 in which the nozzle (12), liquid supply means (14) and the high voltage supply means (26) are embodied in a hand portable unit.

Patentansprüche

1. Verfahren zum elektrostatischen Sprühen, bei dem das Spray von einer Vorrichtung erzeugt wird, die eine Düse (12), Mittel (14) zum Zuführen von Flüssigkeit zu der Düse (12) und ein Hochspannungsversorgungsmittel (26) mit einem Hochspannungsausgangspol (30) aufweist, der in Gebrauch so angeschlossen ist, dass aus der Düse (12) gesprühte Flüssigkeit elektrostatisch geladen wird, wobei die Vorrichtung mit einem durchschnittlichen Potentialgradienten von weniger als 3 kV pro cm über Oberflächen der Vorrichtung zwischen Leitern oder Halbleitern bedient wird, die an entgegengesetzte Pole des Hochspannungsversorgungsmittels (26) angeschlossen sind, **dadurch gekennzeichnet, dass** in Gebrauch elektrischer Kontakt zwischen der Flüssigkeit und dem Hochspannungsversorgungsmittel (26) vorliegt.

2. Verfahren nach Anspruch 1, bei dem die Vorrichtung mit einem Potentialgradienten von weniger als 2 kV pro cm über Oberflächen der Vorrichtung zwischen Leitern oder Halbleitern bedient wird, die an entgegengesetzte Pole des Hochspannungsversorgungsmittels (26) angeschlossen sind.

3. Elektrostatische Sprühvorrichtung, umfassend: eine Düse (12), ein Mittel (14) zum Zuführen von Flüssigkeit zu der Düse, ein Hochspannungsversorgungsmittel (26) mit einem Hochspannungsausgangspol (30), der in Gebrauch so angeschlossen ist, dass aus der Düse (12) gesprühte Flüssigkeit elektrostatisch geladen wird, wobei der größte durchschnittliche Potentialgradient in normalem Gebrauch über Oberflächen der Vorrichtung zwischen Leitern oder Halbleitern, die an entgegengesetzte Pole des Hochspannungsversorgungsmittels (26) angeschlossen sind, weniger als 3 kV pro cm beträgt, **dadurch gekennzeichnet, dass** in Gebrauch elektrischer Kontakt zwischen der Flüssigkeit und dem Hochspannungsversorgungsmittel (26) vorliegt.

4. Vorrichtung nach Anspruch 3, bei der der genannte größte durchschnittliche Potentialgradient weniger als 2 kV pro cm beträgt.

5. Verfahren oder Vorrichtung nach einem der Ansprüche 1 bis 4, bei dem/der das Mittel zum Zuführen von Flüssigkeit zu der Düse einen Druckbehälter (14) der Flüssigkeit mit einem Ablassventil (20) umfasst, welches in Gebrauch durch relative Bewegung des Behälters (14) und der Düse (12) zueinander hin geöffnet wird, wobei die Vorrichtung einen Körper oder Körperteil (2) umfasst, von dem sich die Düse (12) erstreckt, wobei das genannte Ventil (20) in Gebrauch durch relative Bewegung zwischen dem Behälter (14) und dem Körper oder Körperteil (2) geöffnet wird, wobei die Düse (12) in feststehender Beziehung zu dem Körper oder Körperteil (2) bleibt.

6. Vorrichtung oder Verfahren nach Anspruch 5, bei der/dem der Körper oder Körperteil (2) um seinen Umfang herum nicht unterbrochen ist und aus Isolierkunststoffmaterial gebildet ist.

7. Vorrichtung oder Verfahren nach Anspruch 5 oder 6, bei der/dem das Hochspannungsversorgungsmittel einen Generator (26) aufweist, der auf einer Seite des Behälters (14) entfernt von der Düse (12) angeordnet ist und ein Hochspannungsverbindungsglied (30, 32) aufweist, wobei die Niederspannungsschaltung des Generators (26) von dem Behälter entfernt ist.

8. Vorrichtung oder Verfahren nach einem der Ansprüche 1 bis 7, bei der/dem die Düse (12) aus Isolier-

material besteht.

9. Vorrichtung oder Verfahren nach einem der Ansprüche 1 bis 8, bei der/dem das Hochspannungsversorgungsmittel (26) Mittel (100, 102) zum Umwandeln einer Niederspannung von einer Gleichstromversorgung in eine relativ niedrige Wechselspannung, ein Mittel (104) zum Speichern des Energieinhalts der genannten Wechselspannung, Mittel zum wiederholten Entladen des Energiespeichermittels (104) zum Erzeugen einer abklingenden Schwingspannung relativ kleiner Größe höherer Frequenz, ein Hochverstärkungstransformatormittel (108) zum Umwandeln der genannten Spannung höherer Frequenz in eine abklingende Schwingspannung großer Größe und ein Mittel (112) zum Gleichrichten der genannten Spannung großer Größe zum Liefern einer geglätteten einpoligen Hochspannungsausgabe umfasst.

10. Vorrichtung oder Verfahren nach einem der Ansprüche 1 bis 4 oder Anspruch 8 oder 9 wenn angeschlossen an einen der Ansprüche 1 bis 4, die/das ein Gehäuse (2, 4) aufweist, welches für in der Hand gehaltenen Gebrauch geeignet ist und das einen Behälter (14) für die Flüssigkeit aufnimmt, wobei das Gehäuse einen Körperteil (2) umfasst, von dem sich die Düse (12) erstreckt, und der genannte Körperteil um seinen Umfang nicht unterbrochen ist und aus Isolierkunststoffmaterial gebildet ist.

11. Vorrichtung oder Verfahren nach Anspruch 10, bei der/dem der genannte Behälter (14) zusammenlegbar ist und ein Mittel vorgesehen ist, um den Behälter zusammenzudrücken und so Zuführung von Flüssigkeit zu der Düse (12) zu bewirken.

12. Vorrichtung oder Verfahren nach Anspruch 10 oder 11, bei der/dem der Behälter (14) mit einem Ventil (20) versehen ist und bei der/dem Öffnung des Ventils (20) als Reaktion auf Bewegung des Behälters (14) in bezug zu dem Gehäuse (2, 4) bewirkt wird.

13. Vorrichtung oder Verfahren nach einem der Ansprüche 10 bis 12, bei der/dem der zusammenlegbare Behälter (14) innerhalb einer Einfassung eingeschlossen ist, die den Behälter unter Druck setzende Flüssigkeit enthält.

14. Vorrichtung oder Verfahren nach einem der Ansprüche 10 bis 13, bei der/dem der zusammenlegbare Behälter (14) in dem Gehäuse (2, 4) als eine auswechselbare Einheit aufgenommen wird.

15. Vorrichtung oder Verfahren nach Anspruch 11, bei der/dem der zusammenlegbare Behälter (14) innerhalb eines Trägers umschlossen ist, der für Bewegung in dem Gehäuse (2, 4) angebracht ist, und bei der/dem der Behälter mit einem Ventil (20) versehen ist, das als Reaktion auf Bewegung des Behälters (14) in eine vorgegebene Richtung geöffnet wird, wobei das genannte Kompressionsmittel wirksam ist, um Flüssigkeit aus dem Behälter (14) bei Öffnung des Ventils (20) als Reaktion auf eine solche Bewegung auszustoßen.

16. Vorrichtung oder Verfahren nach einem der Ansprüche 11 bis 14, bei der/dem das Gehäuse (2, 4) einen benutzerbedienbaren Auslöser (46) zum Steuern der Zuführung von Flüssigkeit durch das Kompressionsmittel umfasst.

17. Vorrichtung oder Verfahren nach einem der Ansprüche 10 bis 16, bei der/dem das Hochspannungsmittel einen Hochspannungsgenerator (26) aufweist, der für Bewegung innerhalb des Gehäuses (2, 4) angebracht ist, wobei Bewegung des Hochspannungsgenerators (26) als Reaktion auf Betätigung eines benutzerbedienbaren Elements (46) bewirkt wird und Zuführung von Flüssigkeit aus dem Behälter als Reaktion auf eine solche Bewegung des Hochspannungsgenerators oder einer Befestigung (28) für den Hochspannungsgenerator gesteuert wird.

18. Vorrichtung oder Verfahren nach Anspruch 11, bei der/dem der Behälter (14) für Bewegung innerhalb des Gehäuses (2, 4) angebracht ist, und das Kompressionsmittel als Reaktion auf Bewegung des Behälters (14) gesteuert wird, um Freigabe und Sperrung von Flüssigkeitszufuhr zu der Düse (12) zu bewirken.

19. Vorrichtung oder Verfahren nach einem der Ansprüche 1 bis 18, die/das ferner eine Umhüllung (60) aus Isoliermaterial aufweist, die die Düse (12) umschließt und auf der eine Hochspannung der gleichen Polarität wie der an die Flüssigkeit angelegten während Sprühbetrieb der Vorrichtung entwickelt wird.

20. Vorrichtung oder Verfahren nach einem der Ansprüche 1 bis 4 oder Anspruch 8 oder 9 wenn angeschlossen an einen der Ansprüche 1 bis 4, die/das einen röhrenförmigen Körperteil (2), der einen zusammenlegbaren Behälter (14) aufnimmt, welcher zu sprühende Flüssigkeit enthält und mit einem Ventil (20) versehen ist, um die Zufuhr von Flüssigkeit aus dem Behälter zu der Düse (14) zu steuern, wobei der genannte röhrenförmige Körperteil (2) in einer Endkappe (8) endet, die entfernbar ist, um Auswechselung des Behälters (14) zuzulassen, und durch die die genannte Düse (12) vorsteht, und eine Umhüllung (60) aus Isoliermaterial aufweist, die auf der genannten Endkappe (8) so vorgesehen ist, um die Düse zu umschließen, und auf der eine

Hochspannung der gleichen Polarität wie der auf die Flüssigkeit angelegten während Sprühbetrieb der Vorrichtung entwickelt wird.

21. Vorrichtung oder Verfahren nach einem der Ansprüche 1 bis 10, bei der/dem das Hochspannungsmittel einen Hochspannungsgenerator (26) angebracht für Bewegung aufweist, wobei eine solche Bewegung als Reaktion auf Betätigung eines benutzerbedienbaren Elements (46) bewirkt wird, das Teil der Vorrichtung bildet und wirksam ist, um Zufuhr von Flüssigkeit zu der Düse (12) zu steuern.

22. Vorrichtung oder Verfahren nach Anspruch 21, die/das einen länglichen röhrenförmigen Körperteil aufweist, der nacheinander den genannten Hochspannungsgenerator (26), der in Längsrichtung in dem röhrenförmigen Körperteil (2) bewegbar ist, und einen zusammenlegbaren Behälter (14) aufnimmt, der zu sprühende Flüssigkeit enthält und mit einem Ventil (20) versehen ist, das Zufuhr von Flüssigkeit aus dem Behälter zu der Düse (12) steuert und als Reaktion auf die genannte Längsbewegung des Hochspannungsgenerators (26) bedienbar ist.

23. Vorrichtung oder Verfahren nach Anspruch 22, bei der/dem der zusammenlegbare Behälter (14) in einer Einfassung geeigneter Abmessungen zum Übertragen von Bewegung des Hochspannungsgenerators (26) zu dem Ventil (20) aufgenommen wird, um Öffnung des letzteren zu bewirken.

24. Vorrichtung oder Verfahren nach Anspruch 23, bei der/dem die genannte Einfassung elektrisch leitend ist und bei der/dem die genannte Hochspannung von einem Hochspannungsausgang des Hochspannungsgenerators (26) der Düsenspitze über die genannte Einfassung zugeführt wird.

25. Vorrichtung oder Verfahren nach einem der Ansprüche 1 bis 4 oder Ansprüche 7 bis 9 wenn angeschlossen an einen der Ansprüche 1 bis 4, bei der/dem die Vorrichtung einen ersten und zweiten Körperteil (2a, 2b), die in bezug zueinander bewegbar sind, und ein benutzerbedienbares Betätigungselement (46) aufweist, welches Bewegung der Körperteile (2a, 2b) in bezug zueinander in solcher Weise bewirkt, dass das Hochspannungsversorgungsmittel (26) und das Mittel (14) zum Zuführen von Flüssigkeit als Reaktion auf eine solche relative Bewegung betätigt werden.

26. Vorrichtung oder Verfahren nach einem der Ansprüche 1 bis 25, bei der/dem in dem Fall, wenn die Flüssigkeit eine wässrige Flüssigkeit aufweist oder leitender als nichtwässrige Flüssigkeiten mit einer Widerstandsfähigkeit von 1 x 10^5 Ohm/cm ist, die Flüssigkeit aus der Düse (12) als ein Strahl durch Hydraulikdruck abgegeben wird, bevor sie in geladene Tröpfchen zerbricht.

27. Vorrichtung oder Verfahren nach einem der Ansprüche 1 bis 26, bei der/dem die Düse (12), das Flüssigkeitszuführmittel (14) und das Hochspannungsversorgungsmittel (26) in einer von Hand tragbaren Einheit ausgeführt sind.

Revendications

1. Procédé de pulvérisation électrostatique dans lequel la pulvérisation est produite à partir d'un dispositif comprenant une buse (12), un moyen (14) pour fournir un liquide à la buse (12), et un moyen d'allmentation à haute tension (26) ayant un pôle de sortie à haute tension (30) connecté, en cours d'utilisation, de telle sorte que le liquide pulvérisé depuis la buse (12) soit chargé électrostatiquement, le dispositif étant actionné avec un gradient de potentiel moyen de moins de 3 kV par cm en travers de surfaces du dispositif entre des conducteurs ou semi-conducteurs connectés à des pôles opposés du moyen d'alimentation à haute tension (26), **caractérisé en ce que** durant l'utilisation il y a contact électrique entre le liquide et le moyen d'alimentation à haute tension (26).

2. Procédé selon la revendication 1, dans lequel le dispositif est actionné avec un gradient de potentiel de moins de 2 kV par cm en travers de surfaces du dispositif entre des conducteurs ou semi-conducteurs connectés à des pôles opposés du moyen d'alimentation à haute tension (26).

3. Dispositif de pulvérisation électrostatique comprenant : une buse (12), un moyen (14) pour fournir un liquide à la buse, un moyen d'alimentation à haute tension (26) ayant un pôle de sortie à haute tension (30) connecté, en cours d'utilisation, de telle sorte que le liquide pulvérisé depuis la buse (12) soit chargé électrostatiquement, le plus grand gradient de potentiel moyen, en cours d'utilisation normale, en travers de surfaces du dispositif entre des conducteurs ou semi-conducteurs connectés à des pôles opposés du moyen d'alimentation à haute tension (26) étant inférieur à 3 kV par cm, **caractérisé en ce que** durant l'utilisation il y a contact électrique entre le liquide et le moyen d'alimentation à haute tension (26).

4. Dispositif selon la revendication 3, dans lequel ledit plus grand gradient de potentiel moyen est inférieur à 2 kV par cm.

5. Procédé ou dispositif selon l'une quelconque des revendications 1 à 4, dans lequel le moyen pour

fournir un liquide à la buse comporte un récipient pressurisé (14) du liquide ayant une vanne de distribution (20) qui, en cours d'utilisation, est ouverte par un mouvement relatif du récipient (14) et de la buse (12) l'un vers l'autre, le dispositif ayant un corps ou une partie de corps (2) à partir duquel s'étend la buse (12), ladite vanne (20) étant ouverte, en cours d'utilisation, par un mouvement relatif entre le récipient (14) et le corps ou la partie de corps (2), la buse (12) restant en relation fixe avec le corps ou la partie de corps (2).

6. Dispositif ou procédé selon la revendication 5, dans lequel le corps ou la partie de corps (2) est ininterrompu autour de sa périphérie et est formé en une matière plastique isolante.

7. Dispositif ou procédé selon la revendication 5 ou 6, dans lequel le moyen d'alimentation à haute tension comprend un générateur (26) situé sur un côté du récipient (14) à distance de la buse (12) et ayant un connecteur à haute tension (30, 32), le circuit à basse tension du générateur (26) étant distant du récipient.

8. Dispositif ou procédé selon l'une quelconque des revendications 1 à 7, dans lequel la buse (12) est réalisée en une matière isolante.

9. Dispositif ou procédé selon l'une quelconque des revendications 1 à 8, dans lequel le moyen d'alimentation à haute tension (26) comprend un moyen (100, 102) pour convertir une basse tension d'une alimentation C.C. en une tension C.A. relativement basse, un moyen (104) pour stocker le contenu d'énergie de ladite tension C.A., un moyen pour décharger de manière répétée le moyen de stockage d'énergie (104) afin de produire une tension oscillante décroissante de relativement faible amplitude et de fréquence supérieure, un moyen de transformateur à gain élevé (108) pour convertir ladite tension de fréquence supérieure en une tension oscillante décroissante de grande amplitude et un moyen (112) pour redresser ladite tension de grande amplitude afin de fournir une sortie haute tension unipolaire lissée.

10. Dispositif ou procédé selon l'une quelconque des revendications 1 à 4 ou la revendication 8 ou 9 lorsqu' annexée à l'une quelconque des revendications 1 à 4, comprenant un logement (2, 4) adapté à une utilisation portative et qui reçoit un récipient (14) pour le liquide, le logement comportant une partie de corps (2) à partir de laquelle s'étend la buse (12) et ladite partie de corps étant ininterrompue autour de sa périphérie et étant réalisée en une matière plastique isolante.

11. Dispositif ou procédé selon la revendication 10, dans lequel ledit récipient (14) peut s'aplatir et un moyen est fourni pour comprimer le récipient afin de faire arriver le liquide jusqu'à la buse (12).

12. Dispositif ou procédé selon la revendication 10 ou 11, dans lequel le récipient (14) est muni d'une vanne (20) et dans lequel l'ouverture de la vanne (20) est effectuée en réponse au mouvement du récipient (14) par rapport au logement (2, 4).

13. Dispositif ou procédé selon l'une quelconque des revendications 10 à 12, dans lequel le récipient aplatissable (14) est enfermé dans un carter contenant un fluide pressurisant le récipient.

14. Dispositif ou procédé selon l'une quelconque des revendications 10 à 13, dans lequel le récipient aplatissable (14) est reçu dans le logement (2, 4) en tant qu'unité remplaçable.

15. Dispositif ou procédé selon la revendication 11, dans lequel le récipient aplatissable (14) est enfermé au sein d'un support qui est monté pour pouvoir bouger au sein du logement (2, 4) et dans lequel le récipient est muni d'une vanne (20) qui, en réponse au mouvement du récipient (14) dans un sens prédéterminé, est ouverte, ledit moyen de compression servant à expulser le liquide depuis le récipient (14) lors de l'ouverture de la vanne (20) en réponse à un tel mouvement.

16. Dispositif ou procédé selon l'une quelconque des revendications 11 à 14, dans lequel le logement (2, 4) comporte un déclencheur (46) actionnable par l'utilisateur pour commander l'arrivée de liquide par le moyen de compression.

17. Dispositif ou procédé selon l'une quelconque des revendications 10 à 16, dans lequel le moyen à haute tension comprend un générateur HT (26) monté pour pouvoir bouger au sein du logement (2, 4), le mouvement du générateur HT (26) ayant lieu en réponse à l'actionnement d'un élément (46) actionnable par l'utilisateur et l'arrivée de liquide depuis le récipient étant commandée en réponse à un tel mouvement du générateur HT ou d'une monture (28) du générateur HT.

18. Dispositif ou procédé selon la revendication 11, dans lequel le récipient (14) est monté pour pouvoir bouger au sein du logement (2, 4) et le moyen de compression est commandé en réponse au mouvement du récipient (14) en vue d'effectuer l'activation ou la désactivation de l'arrivée de liquide jusqu'à la buse (12).

19. Dispositif ou procédé selon l'une quelconque des

revendications 1 à 18, comprenant en outre un manchon (60) de matière isolante qui encercle la buse (12) et sur lequel une haute tension de la même polarité que celle appliquée au liquide est développée durant l'opération de pulvérisation du dispositif.

20. Dispositif ou procédé selon l'une quelconque des revendications 1 à 4 ou la revendication 8 ou 9 lorsqu' annexée à l'une quelconque des revendications 1 à 4, comprenant une partie de corps tubulaire (2) recevant un récipient aplatissable (14) contenant un liquide à pulvériser et muni d'une vanne (20) pour commander l'alimentation de liquide depuis le récipient jusqu'à la buse (14), ladite partie de corps tubulaire (2) se terminant dans un bouchon d'extrémité (8) qui est amovible pour permettre le remplacement du récipient (14) et à travers lequel ladite buse (12) fait saillie, et un manchon (60) de matière isolante fourni sur ledit bouchon d'extrémité (8) de manière à encercler la buse et sur lequel une haute tension de la même polarité que celle appliquée au liquide est développée durant l'opération de pulvérisation du dispositif.

21. Dispositif ou procédé selon l'une quelconque des revendications 1 à 10, dans lequel le moyen à haute tension comprend un générateur HT (26) monté en vue d'un mouvement, un tel mouvement étant effectué en réponse à l'actionnement d'un élément (46) actionnable par l'utilisateur faisant partie du dispositif et servant à commander l'alimentation de liquide jusqu'à la buse (12).

22. Dispositif ou procédé selon la revendication 21, comprenant une partie de corps tubulaire allongée recevant successivement ledit générateur HT (26) qui peut se déplacer longitudinalement au sein de la partie de corps tubulaire (2) et un récipient aplatissable (14) contenant un liquide à pulvériser et muni d'une vanne (20) qui commande l'alimentation de liquide depuis le récipient jusqu'à la buse (12) et qui est actionnable en réponse audit mouvement longitudinal du générateur HT (26).

23. Dispositif ou procédé selon la revendication 22, dans lequel le récipient aplatissable (14) est reçu au sein d'un carter convenablement dimensionné pour transmettre le mouvement du générateur HT (26) à la vanne (20) en vue d'effectuer l'ouverture de cette dernière.

24. Dispositif ou procédé selon la revendication 23, dans lequel ledit carter conduit électriquement et dans lequel ladite haute tension est fournie depuis une sortie haute tension du générateur HT (26) jusqu'à la pointe de la buse par l'intermédiaire dudit carter.

25. Dispositif ou procédé selon l'une quelconque des revendications 1 à 4 ou l'une quelconque des revendications 7 à 9 lorsqu' annexée à l'une quelconque des revendications 1 à 4, dans lequel le dispositif comprend des première et deuxième parties de corps (2a, 2b) qui peuvent se déplacer l'une par rapport à l'autre et un actionneur (46) actionnable par l'utilisateur qui effectue un mouvement des parties de corps (2A, 2b) l'une par rapport à l'autre de telle façon que le moyen d'alimentation à haute tension (26) et le moyen (14) pour fournir le liquide soient actionnés en réponse à un tel mouvement relatif.

26. Dispositif ou procédé selon l'une quelconque des revendications 1 à 25, dans lequel, dans le cas où le liquide comprend un liquide aqueux ou est plus conducteur que les liquides non aqueux ayant une résistivité de 1×10^5 ohms cm, le liquide est déchargé par la buse (12) sous forme de jet par pression hydraulique avant de se décomposer en gouttelettes chargées.

27. Dispositif ou procédé selon l'une quelconque des revendications 1 à 26, dans lequel la buse (12), la moyen d'alimentation de liquide (14) et le moyen d'alimentation à haute tension (26) sont mis en application dans une unité portative.

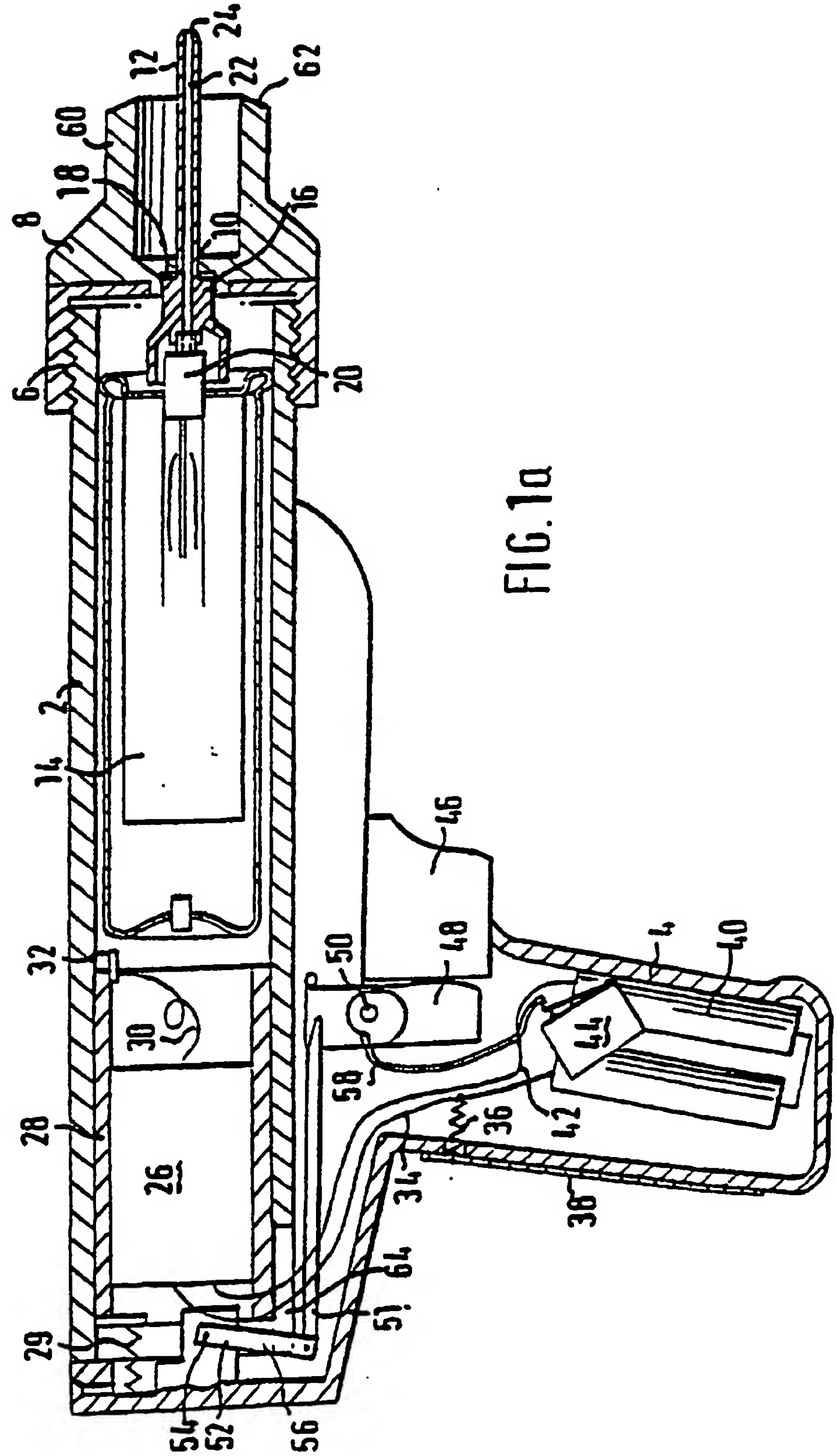
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FIG. 1a

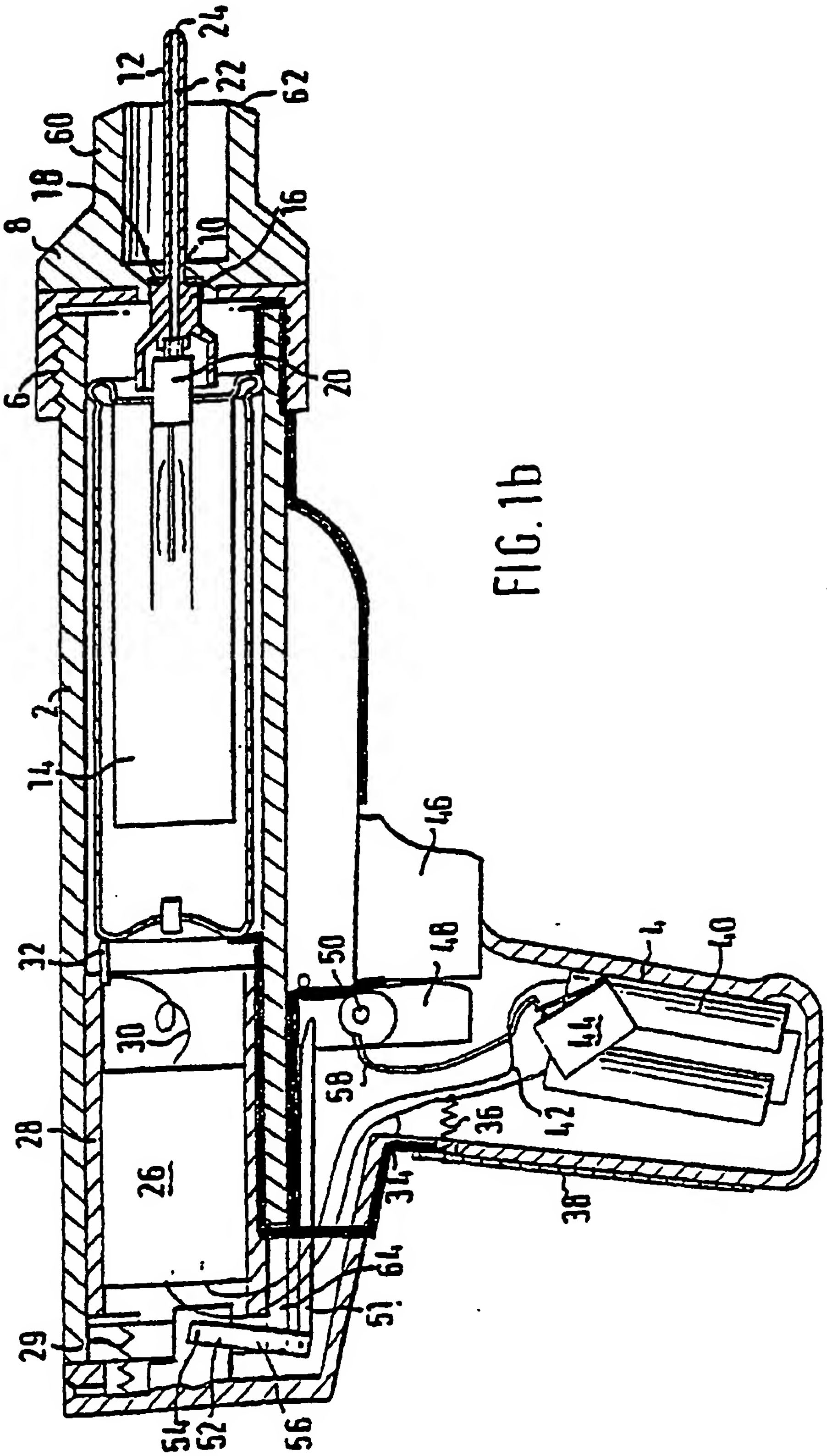

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FIG. 1b

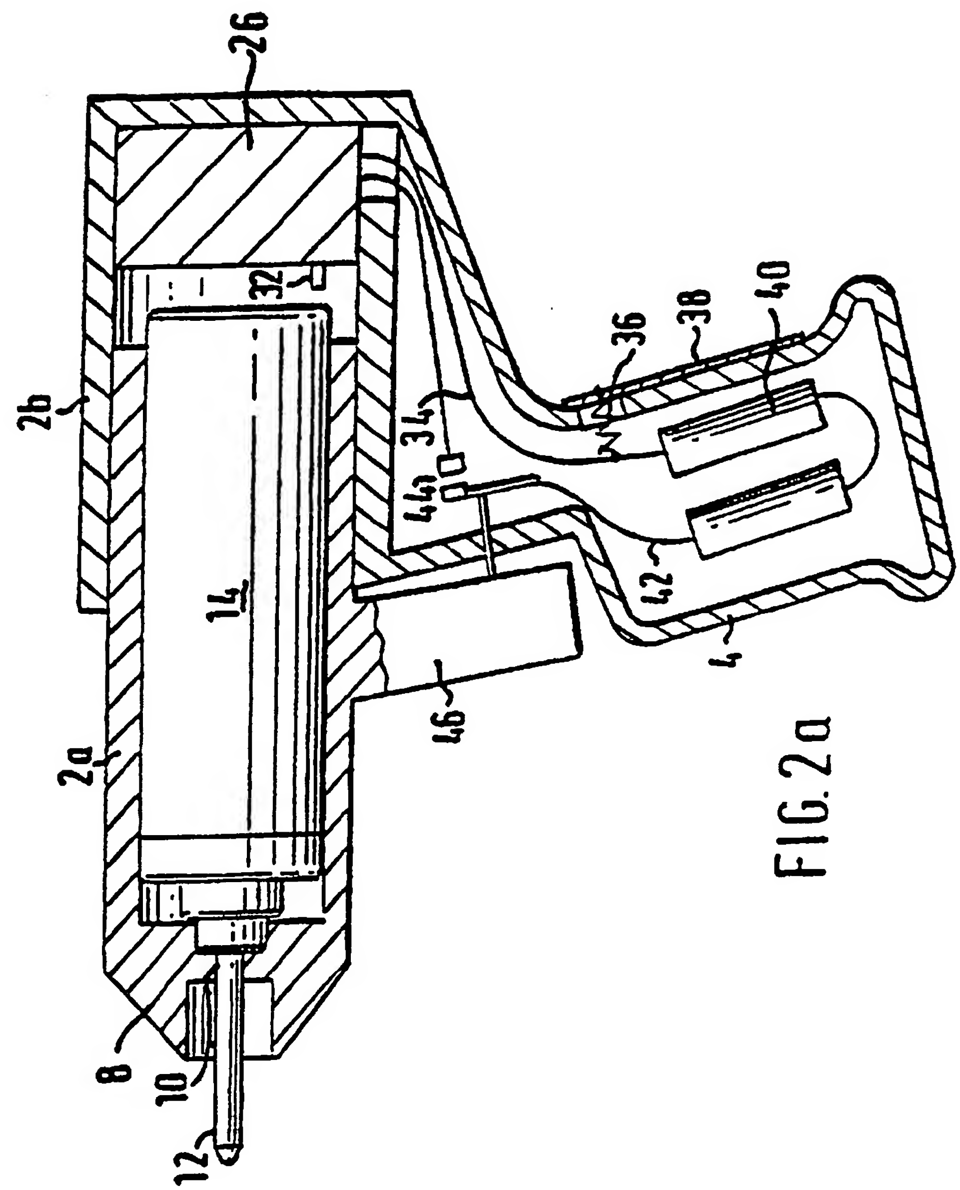

FIG. 2a

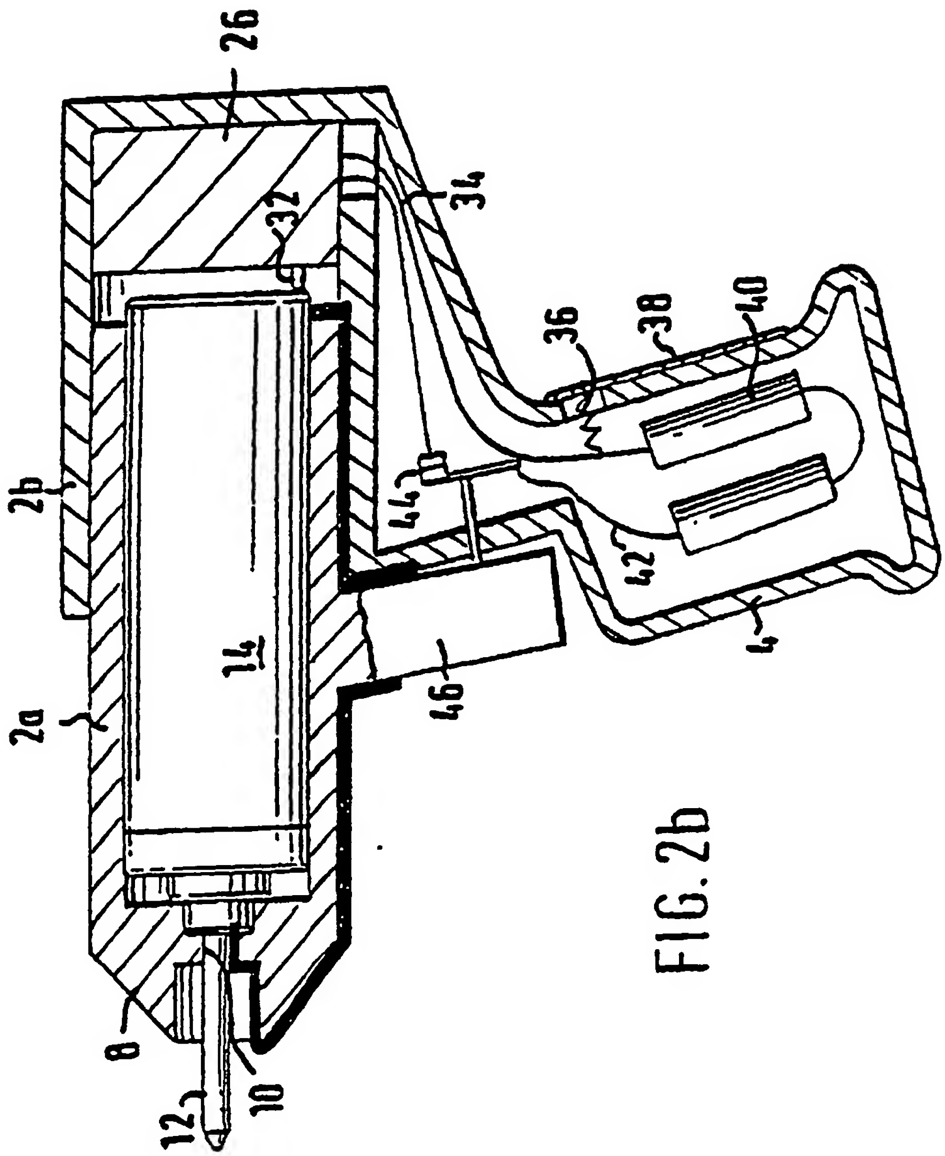

FIG. 2b

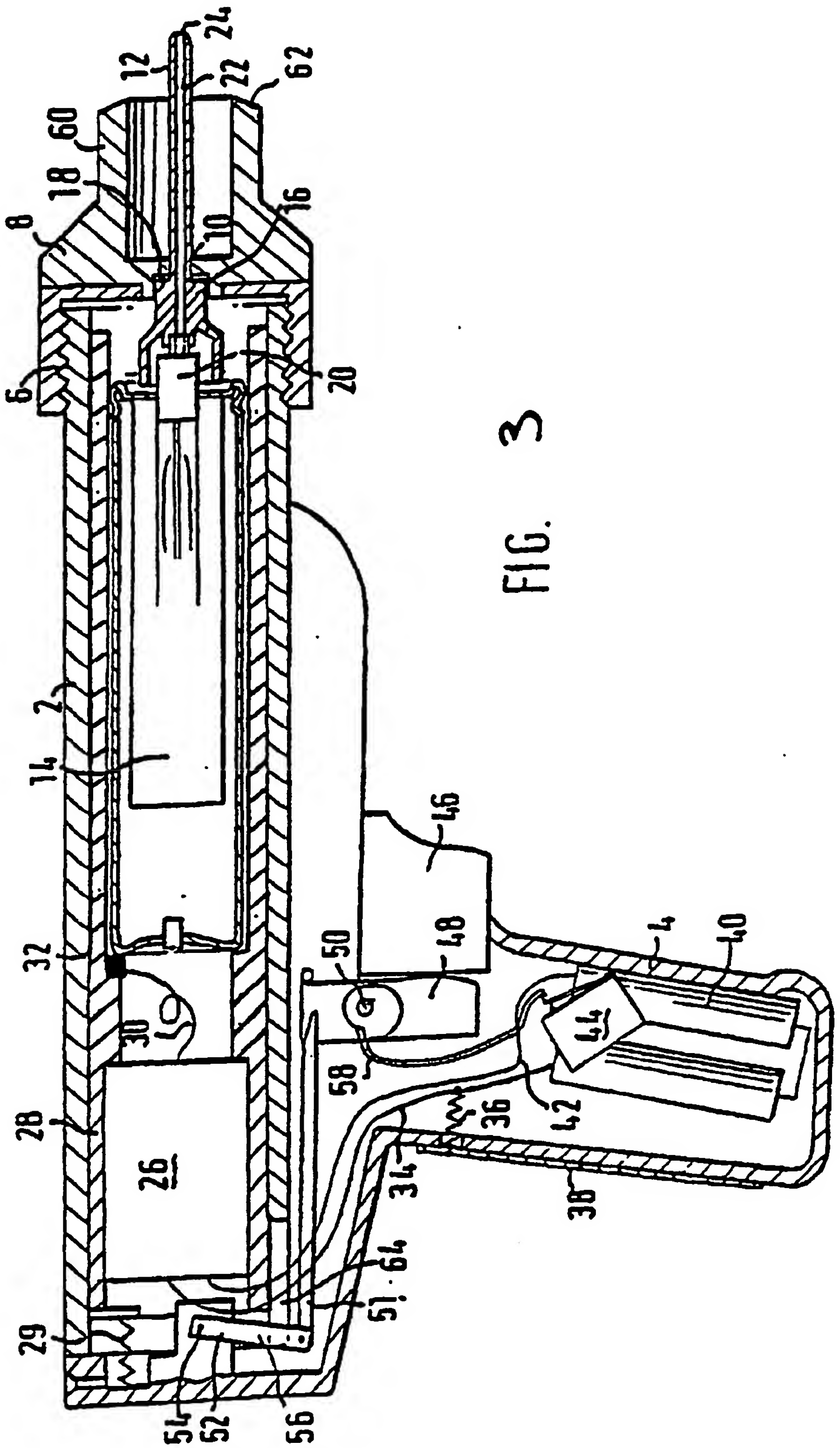
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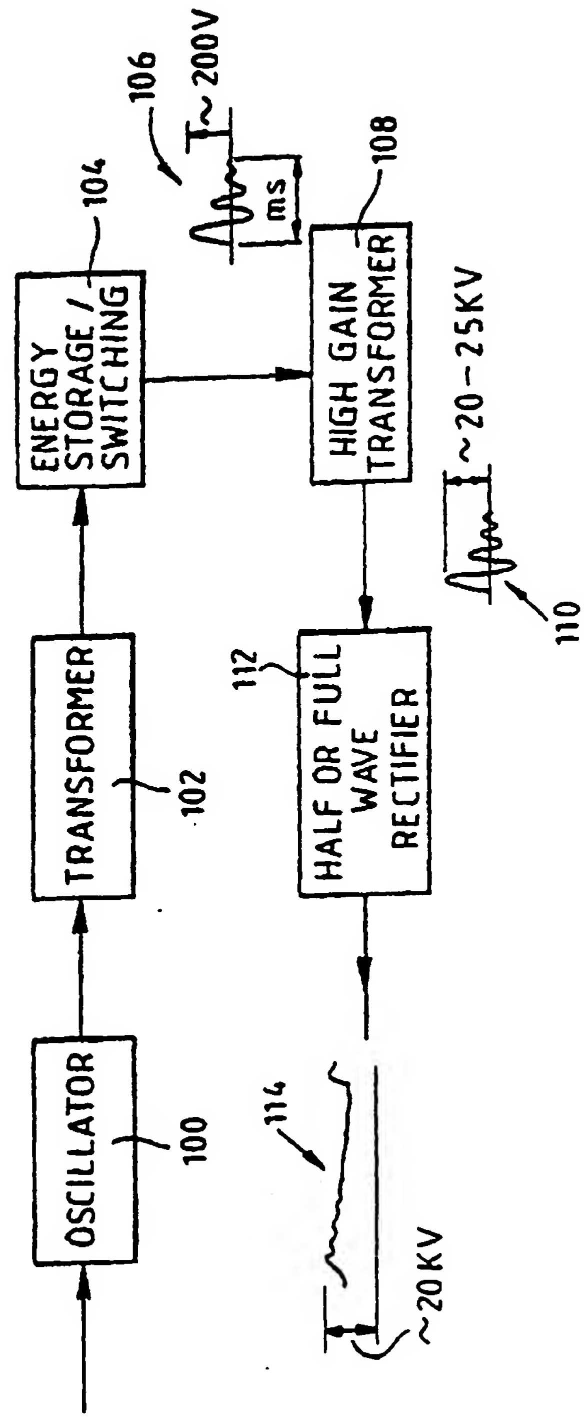
FIG. 3

Fig. 4


OSCILLATOR
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TRANSFORMER
102
ENERGY STORAGE / SWITCHING
104
106
~200V
ms
HIGH GAIN TRANSFORMER
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110
HALF OR FULL WAVE RECTIFIER
112
114
~20KV